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Control of gametophytic selection in Datura through shortening and splicing of styles[1]

J. T. Buchholz,[2] C. C. Doak,[2] and A. F. Blakeslee[3]

(with three text figures)

In the course of our experiments on the control of gametophytic selection, we found that restricted pollinations together with a division of the seed capsules resulted in a very marked increase in the pollen transmission of extra chromosomes in *Datura*.[4] This increase has, for the lower part of the seed capsule, ranged from 49 to 65 per cent with pollen from the 25-chromosome plant Cocklebur. By excision of the part of the style containing the slow-growing pollen tubes in similar pollinations, we obtained a complete non-transmission of the extra Ck. chromosome. In the experiments concerned in this paper, we shall describe a method by which a part of the style containing the more rapidly-growing pollen tubes may be excised and discarded. It follows that this manipulation should result in a nearly perfect pollen transmission of the extra chromosome, permitting the use of more pollen or making unnecessary the division of seed capsules. This procedure necessitated the development of a special technique for reuniting the two parts of the style which had been severed and shortened, or the joining of two different styles in a particular place.

Recently, the discovery of many genes obtained from irradiation whose effect on pollen-tube growth renders them non-transmissible, or only slightly transmissible through the pollen,[5] has stimulated renewed efforts in seeking methods for the control of gametophytic selection. These methods, therefore, fill a definite need in furthering the study of the lethals of pollen-tube growth. Aside from the splicing of styles, there are other manipulations which may ultimately prove successful where a mere shortening of the style is desired, as in the case of self- and cross-sterility.

Some interesting facts concerning pollen-tube behavior were discovered in the course of these investigations which may be advantageously described here. It happens that our technique for the study of the position

[1] This investigation was made possible by a grant from the Committee on the Effects of Radiation on Living Organisms, National Research Council.

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[4] Buchholz, J. T. and A. F. Blakeslee. Pollen-tube growth and control of gametophytic selection in Cocklebur, a 25-chromosome *Datura*. Bot. Gaz. **90**: 366–383. 1930.

[5] Buchholz, J. T. and A. F. Blakeslee. Radium experiments with *Datura*. I. The identification and transmission of lethals of pollen-tube growth in F_1's from radium-treated parents. Jour. Heredity. **21**: 119–129. 1930.

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of the pollen tubes and their distribution within the style at any desired time after pollination[6] has enabled us to observe many phenomena of pollen tube behavior, as well as to determine the success or failure of any type or condition of pollination. Without this technique, it would be difficult or impossible for us to know the degree of success attained in attempted crosses or the cause of failure in the various types of pollinations.

MUTILATIONS OF THE STYLE

We have made attempts to shorten the style by cutting off a portion and pollinating a small area of conducting tissue thus exposed on the wounded surface. In these trials, we found that, due to dessication, the pollen usually would not germinate; when protected against dessication about 20 pollen grains, at best, could be induced to germinate under the most favorable conditions. The exposed area of the conducting tissue was evidently too small. Cutting in diagonal increases this area slightly, but this gives a pointed, more exposed end.

By splitting the style through to the mid-point, placing pollen grains in this wound in direct contact with the conducting tissue, and holding these sides together by means of a straw cut from a grass culm, the pollen was found to germinate very satisfactorily. However, an examination showed that the pollen tubes were growing in both directions. Many of the pollen tubes (sometimes more than half of them) were directed toward the stigma end, where they stopped very close to the exposed style ends from which the stigma had been removed in attaching the straw. Others were growing in the normal direction toward the ovary. This peculiar behavior is of considerable interest in relation to chemotropism and pollen-tube growth. Regardless of this reversal in the direction of some of the pollen tubes, we became convinced from an examination of the dissected preparations, that, as a method of shortening the style, the pollination of the interior of a split style with suitable protection against dessication might be successful in practice, where a shortened pistil is desirable. East and Park[7] reported that they obtained two seed capsules in incompatible tobacco plants by the pollination of pistils which had been mutilated.

The reversal of pollen tubes calls to mind another observation first made nearly ten years ago. At that time, flowers were pollinated, kept in a cool, moist place for several days, and then re-pollinated with the idea of observing the amount of change in the growth-rate of pollen tubes in the

[6] Buchholz, J. T. The dissection, staining and mounting of styles in the study of pollen-tube distribution. Stain Technology. **6**: 13–24. 1931.

[7] East, E. M. and J. B. Park. Studies in Self sterility II. Pollen-tube growth. Genetics. **3**: 353–366. 1918.

partially depleted style of an old flower. A very pronounced decrease in the rate of growth was obtained in the pollen tubes from the second pollination, but a much more interesting phenomenon was observed, namely; that some of the pollen tubes from the first pollination were found to be growing in the reversed direction. They appeared to be emerging from the ovary and growing toward the stigma. An examination of the styles of 30 or more flowers two- and three-days after pollination (self and open pollinated flowers in the field) showed that in more than half of these preparations anywhere from 1–11 pollen tubes were growing in the direction of the stigma. In flowers only a day old, there were very few reversed pollen tubes.

Possibly we should revise some of the commonly accepted ideas concerning chemotropism and pollen-tube growth in the light of these observations. There is certainly a question as to whether chemotropism, if present, exerts its influence through the length of the style. If a pollen tube happens to become reversed in its orientation at any time, it will continue its growth toward the stigma. On the stigma there is only one direction in which a pollen tube may grow and find nutriment when the pollen grain germinates. All cells of the stigma and conducting tissue are so oriented that the path of least resistance (the long axis of the nutritive cells) leads them in the direction of the ovary. Once the pollen tubes are started in this direction there is usually nothing to reverse their orientation, but within the ovary, we find that the path followed becomes very devious and irregular. (We have successfully dissected the entire conducting tissue from the pistil, removing the ovules which remained attached to the dissection by their pollen tubes.) If the ovules in the path of a particular pollen tube have been previously fertilized, and it happens to find its way back to the conducting tissue through which it entered, it may emerge from the ovary and continue its growth toward the stigma. Of course, these observations do not necessarily deny the existence of chemotropism at the time a pollen tube enters the micropyle.

SPLICING OF STYLES IN CUT FLOWERS

Our experiments, in which we spliced styles on cut flowers which were kept in the laboratory, revealed some very interesting features. We found that when the parts of two different styles were joined perfectly in square joints, properly protected, and held in this position, many pollen tubes could pass across the wounded area. When the styles were not perfectly joined, the ends of the pollen tubes would enlarge considerably and extend themselves slightly beyond the conducting tissue as they were stopped. Figure 1 is taken from one of our laboratory tests, and shows the

behavior of pollen tubes at the joint between two styles. This figure is from a camera drawing of a selected part of this region and the conducting tissue is only schematically represented. The pollen tubes shown at the left had little difficulty in passing through the wounded area; those shown at the right were held in check by the gap at this point between the two neighboring conducting tissues. Some of the pollen tubes were attempting to cross the barrier and the figure shows how they may crowd up to and extend themselves beyond the extreme end of the upper cut surface. With the first tubes as support, others may extend themselves farther and

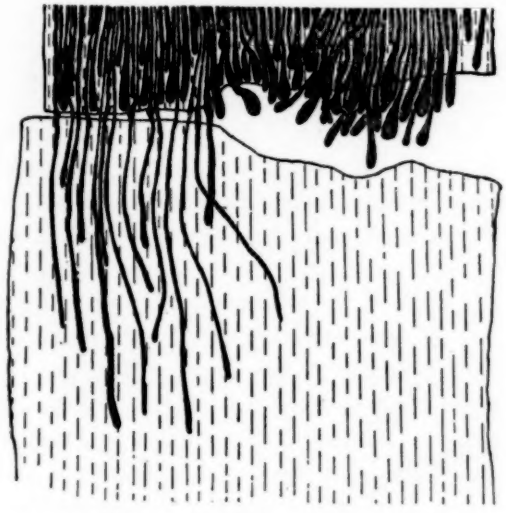


Fig. 1.

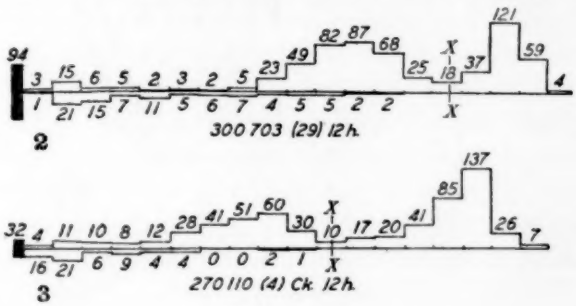
farther. Thus it could be observed in many instances that when crowded, a few of the pollen tubes may somtimes actually find their way across a considerable space to the nourishing tissue beyond the gap and continue their growth to the ovary.

These observations demonstrated the importance of obtaining a perfect union of the two strands of conducting tissue in the styles which are spliced. Though some pollen tubes are held in check at the joint, we counted hundreds of pollen tubes in our test slides which successfully passed over into the second style. We were, therefore, encouraged to make attempts to obtain seed capsules from such pollinations.

BI-MODAL DISTRIBUTIONS OF POLLEN TUBES

The conditions under which it may be desirable to splice a style are illustrated by the pollen tube distributions shown in figures 2 and 3. Here we find the pollen tube population, growing under favorable conditions,

and resolved into two groups. Only the ends of the pollen tubes were counted and plotted in their appropriate interval as they were growing from the stigma at the left toward the ovary at the right. Burst pollen tubes are plotted below the datum line and any ungerminated pollen grains are shown by the vertical bar at the left. Figure 2 shows a test using a moderate amount of the pollen of an F_2 plant derived from irradiation experiments. The bi-modal distribution is due to a gene which is recessive in the sporophyte carrier. Genes of this type are usually transmitted through half of the eggs, giving very satisfactory 1:1 ratios. Half of the male gametophytes also receive the gene which retards their growth. The group of long pollen tubes are growing at the same rate as those obtained from the pollen of normal plants. Their arrival in the ovary several hours before the second group, may enable them to monopolize the ovules



Figs. 2 and 3.

and leave none to be fertilized by the second group of pollen tubes which, therefore, may appear not to be transmitted through the pollen in ordinary pollinations. Since the pollen tubes in the longer group could only contribute the dominant allelomorph of this gene upon fertilization it is desirable to eliminate this group entirely and obtain a result similar to a back cross to the recessive, if this plant is selfed.

Likewise, in figure 3 from the pollen of one of the 25-chromosome plants where an extra chromosome is carried in the slow-growing half of the pollen tube population, we may wish to eliminate the longer pollen tubes which do not carry the extra chromosome. Since an extra chromosome behaves as a dominant character in heredity we may expect to approach 100 per cent transmission of this condition, if the fast growing pollen tubes are eliminated.

METHOD OF SPLICING STYLES

The splicing of styles on plants growing out of doors was most successful when done at night. The method which was finally elaborated is illustrated by steps in A-J, in figure 4.

Healthy, cut flowers from normal plants were pollinated under controlled conditions. Pollen was used which was known to give a bi-modal distribution of tubes. After sufficient growth had been attained to separate the two groups (8–12 hours at 18–20 degrees C.), one or more styles were killed, dissected, and stained as rapidly as possible (at least 30 minutes required). When properly stained, the condition of the tubes and the position of the two modes were determined by actual measurements. The distance from the stigma to the low point X between the two modes was measured and marked with parallel lines on a wooden gauge. This gauge

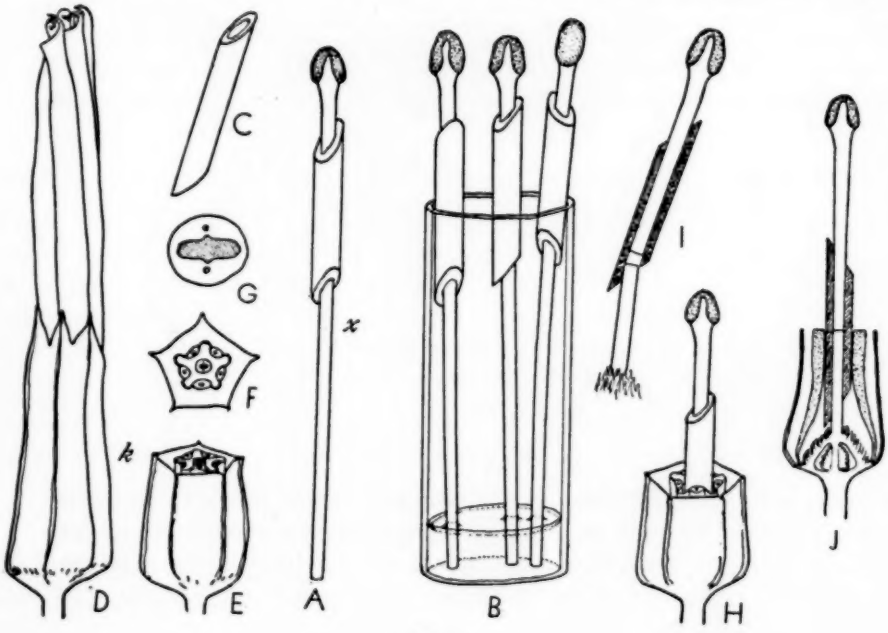


Fig. 4.

served as a guide in cutting the styles in the field. While the test slide and gauge were in process of preparation, the styles were removed from the remaining flowers and inserted into previously selected, closely-fitting grass straws C, as shown at A (the living culms of *Digitaria sanguinalis* were used). These were immediately set in vials containing a small quantity of water (fig. 4B) and transported to the field in this condition.

All the paraphernalia required for the field work *must be prepared in advance*, for speed and accuracy may determine the difference between success and failure. The following equipment is needed:

(1) Suitable tags showing pollination legends.

(2) A hunter's headlamp for each operator. These free both hands for

work and give a narrow beam of intense light which is necessary for the rather delicate manipulations.

(3) A sharp razor for each operator.

(4) A wooden gauge as described above, marked in such a way as to enable one of the operators to cut the style quickly, squarely and at the desired point corresponding to the low place (X) between the two modes shown in figs. 2 and 3.

(5) A small portable stool or table for instruments and material.

On the plant which is to serve as maternal parent a nearly mature, unopened bud is selected, one whose pollen has not been shed, such as is shown at D. At the point *k*, the fluted inner surface of the corolla is found to be constricted as shown in figure 4 at E and F. This constriction furnishes a natural clamp for holding the straw splint in place, as shown in position at *H*. For this reason the point *k* is selected and cut by one operator. At the same time the other operator places a style on his gauge and makes a clean square cut at the predetermined desired distance from the stigma and then discards the lower part of the style together with its contained tubes. The stigmatic portion together with its slow-growing tubes is retained and its newly cut surface drawn up into the body of the splint as seen at I. The straw is then carefully lowered over the newly cut end of the lower style which remains on the plant, as shown at I, H and J. The instant that the two cut surfaces come in contact further lowering of the straw thrusts upward the part bearing the stigma. Thus one may know when contact is made and the process is complete. If this operation is carefully carried out on field plants and then left undisturbed for a period of 10–12 hours, a sufficient number of fertilizations may be accomplished to cause a fruit to set. It is usually a small one, especially if the fast-growing tubes have been discarded, but contains sufficient seed to give as large a culture as one usually wishes to plant.

PRECAUTIONS

For the greatest success, certain precautions should be borne in mind. (1) General growth conditions and fruit setting should be good. (2) A rather high degree of atmospheric humidity is also necessary because otherwise the cut surfaces dry quickly and stop the passage of tubes. For this reason, we worked at night after the air approached the dew point. In damp weather, the operations can be performed in the evening thus taking advantage of twilight. (3) As will be seen from the cross section of the style G, fig. 4, the strand of conducting tissue is not circular, but elongated in cross section. If the two abutting strands are properly orientated, a perfect union is made, otherwise many tubes will be stopped be-

cause they find no continuity of conducting tissue at this point. In practice, this structural difficulty can be only partly overcome. (4) The straw splints, C should be obtained from living plants, and carefully selected to fit the style very closely. Diagonally cut ends will facilitate their insertion.

This method should not be called grafting. The tissues of a style are mature and do not unite by meristematic growth. They are merely brought closely together and held in place. If the splicing has been successful we estimate that the pollen tubes usually cross the joint within a 5–9 hour period following the operation. The pollen tubes actually serve as a bond to hold the united parts together, but the upper part of the joined style frequently dries out long before the lower portion, showing that no actual organic union of the stylar tissues occurs.

SEEDS FROM SPLICED STYLES

Our first attempts in splicing the styles on garden plants were made with normal pollen. We were naturally interested in demonstrating the possibility of obtaining successful fertilization by this method regardless of pollen tube distributions. In some cases, we cut off only a portion of the longest pollen tubes or made our incision in front of all of them. The seed capsules from 15 successful trials contained from 5–175 seeds, an average of 72. In another set of trials, we obtained from our successful attempts from 50–275 seeds, an average of 120. In a set of experiments using the pollen of (2n+1) Globes, we obtained 7 capsules ranging from 35–175 seeds with an average of 100.

We have now made a total of 50 successful pollinations with spliced styles. Many of these are from crosses in which the desired phenotypes would not appear in ordinary pollinations. The latter have not been planted as this is written. From the last series, the ovaries which dropped without setting fruits were collected and dissected. These yielded some valuable data concerning the minimum number of fertilizations required in an ovary to ensure a reasonable probability of a set. We found that 36 had no ovules fertilized, 15 had between 1 and 10 fertilizations, 15 had 11–20 enlarged ovules and 2 others between 21 and 30. Among the successful sets there were no capsules with less than 10 seeds, 3 with 11–20, 2 with 21–30, 5 with 31–50 and 13 with from 51–140 seeds each. Thus it appears that a minimum of about 20–30 ovules should be fertilized in order to ensure the setting of seed capsules in field-grown plants at times when the conditions of fruit setting are favorable.

Some of the crosses Normal X (2n+1) Globe were planted in order to test the Globe-transmission through the pollen by this method. Though the highest had only 31 per cent Globes, which is fewer than we might

expect to obtain, this is about a 15-fold increase over Globe-transmission in ordinary pollinations, and demonstrated that the 13-chromosome gametophyte of this mutant could be successfully transmitted by the method of splicing styles. Evidently we had placed our incision too far forward, thus including a majority of 12-chromosome pollen tubes. In our later experiments, in which the place of incision was determined with greater accuracy, so that more of the longer pollen tubes were discarded, the proportion of the progeny especially desired was much higher, in spite of the fact that the average number of seeds obtained was lower.

PROGENY TESTS AFTER STYLE-SPLICING

TABLE 1

	Planting number	Plants from first or longest pollen tubes No.	Plants from second group of pollen tubes No.	Plants from second group of pollen tubes %	Total plants recorded Half caps	Total plants recorded Whole caps	Per cent from 2nd group of pollen tubes
Controls—Double pollinations, styles not spliced	U½ 31737	189	25	11.7	214	400	25.0
	L½ 31738	111	75	40.3	186		
	U½ 31739	201	10	5.0	211	440	19.1
	L½ 31740	155	74	32.3	229		
	U½ 31742	236	1	0.4	237	510	3.3
	L½ 31743	257	16	6.2	273		
	U½ 31748	200	2	1.0	202	388	12.0
	L½ 31747	139	47	25.3	186		
						Average for Controls	14.8
Tests—Double pollinations, styles spliced, discarding longest pollen tubes	U½ 31744	4	20	83.3	24	54	85.1
	L½ 31745	4	26	86.6	30		
	U½ 31749	1	35	97.2	36	62	74.2
	L½ 31750	15	11	42.3	26		
	31736	15	25			40	62.5
	31741	3	47			50	94.0
	31746	7	27			34	79.4
	31751	5	49			54	90.7
	31753	2	17			19	89.4
	31754	1	9			10	90.0
	31755	5	25			30	83.3
						Average	83.2
	31752*	25	4			29	13.2

* Style was cut too far foward, including longest group of pollen tubes.

In order to test the possibilities of this technique with distinct bimodal distributions of pollen tubes, we made some double pollinations using pollen which was known to give only a single mode of distribution from each separate pollination. The two pollinations were separated by an interval of four hours thus giving two modes. By using the pollen of the dominant gene for purple flowers and seedlings in one pollination, and the pollen from white plants in the other, and splicing these onto the flowers of white plants, we could tell from the color of the seedlings whether the desired group of longer pollen tubes had been excised. Table 1 gives the results of these tests together with similarly pollinated control-flowers which were not spliced.

The first four pollinations given in table I were some of our controls, and were divided into pedigrees representing seeds from the upper and lower half of the seed capsules. It is obvious that the pollen tubes of the second pollination (which were largely excised in treated styles) were almost completely excluded from the upper half of the seed capsules, but fertilized ovules in the lower portion to a much greater extent. The average for the entire capsules in the controls was about 15 per cent.

In our splicing tests the proportions obtained from the second pollination ranged between 62.5 and 94 per cent, with an average of 83.2 per cent. This is nearly a six-fold increase over the controls. However, one case (Planting #31752 listed at the bottom of this table) gave practically the same results as the unspliced controls. In this case, there can be little doubt that the incision was made too far forward, thus including all or nearly all of the longest group of pollen tubes. This serves to demonstrate the importance of knowing accurately the point X (see figures 2, 3 and 4A) at which the incision is to be made in order to discard the longest group of pollen tubes. On the whole, these genetic tests indicate that the method of splicing styles is practical, and may be expected to give greatly increased yields of zygotes coming from slow-growing pollen tubes.

The genetics of Neurospora—II. Segregation of the sex factors in asci of N. crassa, N. sitophila, and N. tetrasperma

CARL C. LINDEGREN

(WITH FIVE TEXT FIGURES)

Dodge (1927) has pointed out some of the advantages of the ascomycetes for studying meiosis. The primary nucleus of the ascus is formed by the fusion of two nuclei. The cell containing this nucleus gives rise to the ascus which is often long and tube-like. This nucleus then divides three times to form eight nuclei. Each of the eight spores receives one of these eight nuclei. In *Neurospora crassa* and *N. sitophila* an ascospore on germination gives rise to a mycelium, which may be of either one of the two sexes. Such a mycelium, usually called a 'haploid' mycelium, is sterile when grown alone or with another of the same sex, but, when the mycelia of two opposite sexes grow together, zygotes and ascospores are produced.

SEX AND ARRANGEMENT OF SPORES IN THE ASCUS OF NEUROSPORA CRASSA

In the two species mentioned, the tube-like ascus is long and narrow. Wilcox (1928) has studied the spindles in the ascus of *N. sitophila* and has found that, in the first two divisions, they are oriented parallel to the sides of the ascus and do not overlap. The nuclei maintain their relative order and positions. This means that it is possible, as shown in text figure 1, to determine at which division segregation of factors has taken place. This is done by studying the characters of the mycelia grown from the respective ascospores of a single ascus in which the position of the spores in the ascus is known. Text figure 1 shows three of the six possibilities for first- versus second-division segregation. The other three are represented by reversing the positions of the two kinds of nuclei. In text figure 1, a, showing first-division segregation, the upper four nuclei would be 'white' and the lower four 'black'.

Dodge (1929b) and Wilcox (1928) have shown in *Neurospora sitophila* that the factors for cultural characters and the factors determining the two sexes can be segregated at either the first or at the second division in the ascus. Dodge (1927) presented cytological evidence that in *N. tetrasperma*, a species containing four bisexual spores, where there is a very complex series of changes in spindle orientation, there is a greater probability of the sex factors being segregated at the first division than at the second. He also points out that the sex factors might be segregated at any one of the three divisions and still give rise to four bisexual spores. He studied the segregation of the sex factors in *N. crassa* (1930, 1931), and

stated that they were segregated at the first division in this species. By means of the arrangement of the spores in the long narrow ascus, the writer has also studied the segregation of the factors for the two sexes and for various pairs of cultural characters in *N. crassa*. Segregation was found not to occur at the third division, since, for all characters, the spores were found grouped as four pairs of identical twins. Dodge's study of the orientation of the spindles in this species shows that it is probably identical with that of *N. sitophila*. All of the asci, from which eight spores germinated, showed four spores of one sex and four of the opposite sex. The possible

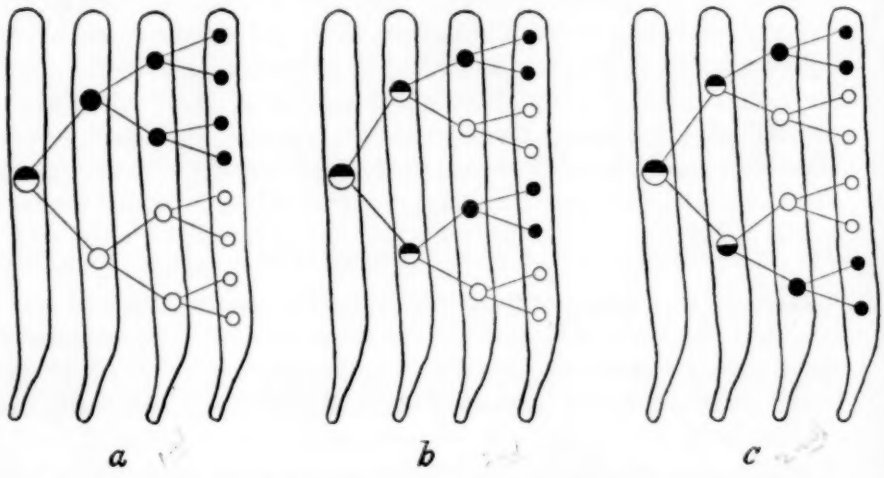


Fig. 1. a. Diagram of the arrangement of spores of opposite sex in the ascus of *N. crassa* that would result from segregation of the sex factors at the first division in the ascus, provided there was no passage of nuclei in the ascus. Black and white are used to designate the factors for the opposite sexes. The only variation of this arrangement that has been detected is a shift in the fourth and fifth place, giving three black, one white, one black, and three white nuclei. But this shift is rather infrequent. The second obvious possibility of a first-division segregation would result from the opposite orientation of the tetrad in the first division. The second ascus would then show a white nucleus above and a black one below, and the final arrangement in the ascus would be reversed. b. Diagram showing the arrangement of spores of opposite sex in the ascus that would result from a segregation of the factors for sex at the second division in the ascus and a failure to segregate them at the first division. A second possibility would result from changing the orientation of both nuclei in the binucleate stage. In this case, the last figure would show, from top to bottom, two white, two black, two white, and two black. Ascus 348 is an example of a shift in positions 2 and 3, following this type of segregation. c. Diagram of another arrangement of spores of opposite sex in the ascus of *N. crassa*, which would result from a second-division segregation of the factors for sex. If both nuclei in the binucleate stage were reversed, another possibility would be obtained with the four black nuclei in the center and two white at each end. Ascus 301 shows the change in this arrangement resulting from a one place shift.

arrangements in an ascus for eight spores, four of one sex and four of the opposite sex, are seventy. This is given by the formula:

$$\frac{8!}{4!\times 4!}=70$$

Table 1 shows 32 of the asymmetrical and the 6 symmetrical permutations.

TABLE 1

Permutations of ascospores in the ascus

SPORE 1	2	3	4	5	6	7	8
32 OF THE ASYMMETRICAL PERMUTATIONS							
+	+	+	+	−	−	−	−
+	+	+	−	+	−	−	−
+	+	+	−	−	+	−	−
+	+	+	−	−	−	+	−
+	+	+	−	−	−	−	+
+	+	−	+	+	−	−	−
+	+	−	−	+	+	−	−
+	+	−	−	−	+	+	−
+	+	−	+	−	+	−	−
+	+	−	−	+	−	+	−
+	+	−	−	−	+	−	+
+	+	−	+	−	−	+	−
+	+	−	−	+	−	−	+
+	+	−	+	−	−	−	+
+	−	+	+	−	−	−	+
+	−	−	+	−	+	−	+
+	−	−	−	+	+	−	+
+	−	+	−	+	−	−	+
+	−	+	−	+	−	+	−
+	−	−	−	+	+	+	−
+	−	−	+	+	+	−	−
+	−	+	−	−	+	+	−
+	−	−	+	−	+	+	−
+	−	+	+	−	+	−	−
+	−	+	+	+	−	−	−
+	−	+	−	+	+	−	−
+	−	−	+	+	+	−	−
+	−	+	+	−	−	+	−
−	−	+	+	−	+	+	−
−	−	+	+	+	−	+	−
−	−	+	−	+	+	+	−
−	−	−	+	+	+	+	−
THE 6 SYMMETRICAL PERMUTATIONS							
+	+	−	−	−	−	+	+
−	−	+	+	+	+	−	−
+	−	+	−	−	+	−	+
−	+	−	+	+	−	+	−
+	−	−	+	+	−	−	+
−	+	+	−	−	+	+	−

The remaining 32 asymmetrical permutations are obtained by an end to end reversion of the 32 asymmetrical ones shown. If the arrangement of spores in the ascus is determined by pure chance, there is one chance in 70 of each such permutation occurring.

The six arrangements, of which three are shown in text figure 1, could all be the result of either first- or second-division segregation, provided the spindles in the second division were long enough and the ascus wide enough to permit the two middle nuclei to pass each other in the four-nucleate stage, as is the case in *N. tetrasperma*. Text figure 2, a is a diagram showing such a shift in position. With such a shift, a first-division segregation would produce the arrangement usually ascribed to second-division segregation and vice versa. If such a shifting occurred, it might be ob-

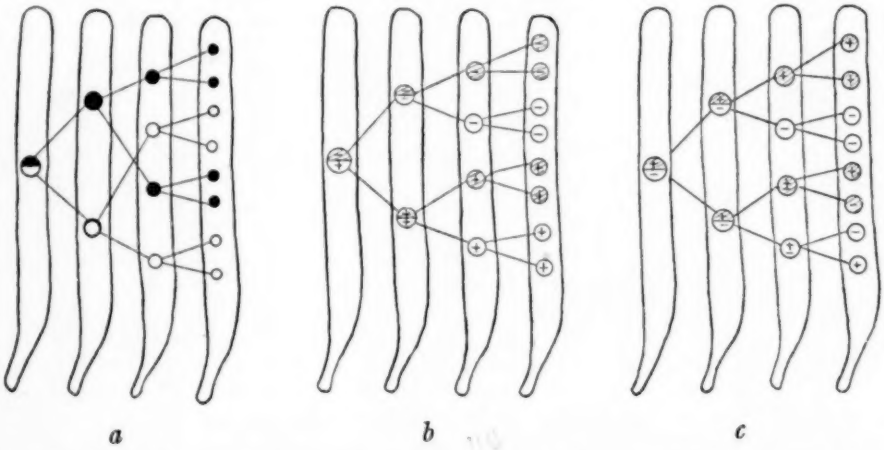


Fig. 2. a. Diagram showing how the transposing of the second and third nuclei in the four-nucleate stage would result in first-division segregation producing the arrangement of spores ascribed to second-division segregation and vice versa. The cytological evidence of Wilcox and Dodge show this to be highly improbable. b. Diagram of the arrangement of the spores of opposite sex and producing tan and wild-type mycelia in ascus 114. Diagonally lined nuclei are wild-type and open nuclei are tan. This arrangement of spores proves that, even if a shift as shown in figure 2,a had taken place, both first- and second-division segregation occurred. c. Diagram of a hypothetical ascus showing an arrangement of spores of opposite sex and different cultural characters that would prove that third-division segregation had occurred. No such ascus has been found.

jected that the data do not show evidence of more than one type of segregation. But Wilcox (1928), in her cytological study of a closely related species, *N. sitophila*, shows that no such shifting takes place. Moreover, ascus 114 (text fig. 2, b) proves that both first- and second-division segregations occur. A character, which was called tan, appeared in the mycelia

grown from the ascospores of this ascus. The conidia of tan were produced more sparsely than in the wild-type, and were white or yellow, while those of the wild-type were orange or light orange. In text figure 2, b, it can be seen that the sex factors were segregated at the first division, while wild and tan were segregated at the second. Even if it were assumed that the second and third nuclei exchanged positions after the second division, the results show that both first- and second-division segregations must have taken place.

Table 2 is a record of the sex and arrangement of the ascospores in 275 asci of *N. crassa*, comprising six generations. These asci are all descended from a single ascus. In each column, the numbers at the left are the numbers of the individual asci. The plus sign indicates that the mycelium of the respective ascospore produced fertile perithecia when mated to a tester strain. The minus sign indicates that no perithecia were produced by a similar mating. The plus sign indicates that the ascospore is opposite in sex to the tester strain, and the minus sign indicates that it is the same sex. The eight spaces from left to right correspond to the positions of the ascospores in the ascus. The first position indicates the ascospore located at the tip of the ascus and the eighth position indicates the ascospore located at the base. A bracket at the left of the numbers of the asci indicates that all of the asci bracketed come from one perithecium and the number at the left of the bracket is the number of the perithecium. Above each group is shown the mating which produced the corresponding asci. For example 0–1×6–2 means mating the mycelium from the first ascospore in ascus 0 to the mycelium from the second ascospore in ascus 6. The symbols I×I following indicate that ascus 0 was an ascus in which the sex factors were segregated at the first division in the ascus, and ascus 6 was an ascus in which the sex factors were also segregated at the first division. Roman numeral II is the symbol used to indicate second-division segregation of the sex factors.

When a spore does not germinate its position is indicated by a circle. When it is possible from the position and sex of the other spores to determine the sex of the missing spore, a plus or minus sign is placed within the circle. From the fact that, in every case where all eight spores germinated, there were four of one sex and four of the opposite sex in the ascus, this determination is easy to make.

The arrangement of the spores in the asci shows that segregation of factors determining sex may occur either at the first or the second division in the ascus. Exceptional asci are marked by parentheses. These undoubtedly are all due to slipping of adjacent nuclei past each other during or after the third division. Rough handling in dissection might cause shifting of

TABLE 2

Sex and arrangement of ascospores in 275 asci of Neurospora crassa.

P_3 Generation

Ascus								
0	−	−	−	−	+	+	+	+

P_2 Generation (0–1×0–8) I selfed

Ascus								
(1)[a]	−	−	+	+	+	−	−	+
2	−	−	+	+	+	⊕	−	−
4	−	−	−	⊖	+	+	+	+
5	+	+	+	⊕	−	−	⊖	−

Ascus								
6	+	+	+	+	−	−	−	−
7	⊕	+	+	+	−	−	−	−
(10)[a]	○	−	−	+	+	○	−	○

4 I:2 II; 1 (?)

Back Cross Generation $P_2 \times P_3$

(0−1×6−2)I×I

Ascus								
113	−	⊖	+	⊕	+	+	−	−
114	−	−	−	−	+	+	+	+
116	+	+	−	−	−	−	+	+
118	+	+	+	⊕	−	−	−	−
120	+	+	−	−	+	+	−	−
122	−	−	−	−	+	+	+	+
123	−	−	−	−	+	+	+	⊕
124	⊕	+	+	+	−	−	−	−
126	+	+	+	+	−	−	−	−
125	−	−	−	−	+	+	+	+
127	+	+	+	+	−	−	−	−
128	+	+	+	+	−	−	−	−
129	+	+	+	+	−	−	−	−
130	+	+	+	+	−	−	−	−
131	−	−	−	−	+	+	+	+
132	+	+	+	+	−	−	−	−
133	+	+	+	+	−	−	−	⊖
134	+	+	+	+	−	−	−	−
136	+	+	−	−	−	−	+	+

15 I:4 II

(0−1×7−3)I×I

Ascus								
137	137	−	−	−	−	+	+	⊕	+
	139	−	−	−	−	+	+	+	+
	141	−	−	−	−	+	+	+	+
	142	+	+	−	−	−	−	+	⊕
	144	⊖	⊖	−	−	+	+	+	+

4 I:1 II

(0−1×10−4)I×II (?)

Ascus								
106	+	+	+	+	−	−	−	−
107	−	−	−	−	+	+	+	+
(109)[a]	−	−	−	⊕	−	+	+	+
110	−	−	+	+	−	−	+	⊕
112	+	+	+	+	−	−	−	−

4 I:1 II

(0−1×1−3)I×II (?)

Ascus								
100	⊖	−	−	−	+	⊕	+	+
101	−	−	+	+	+	+	⊖	⊖
103	−	−	−	−	⊕	+	+	+
104	+	⊕	⊕	+	−	−	−	−

3 I:1 II

[a] The parentheses enclosing the ascus number throughout this table indicate that a shift of the nuclei, after the third division, may have occurred or the spores were misplaced in the manipulation.

P_1 Generation (4−5×6−5)I×I

Ascus								
299	⊕	+	+	+	−	−	−	−
(301)	+	−	+	−	−	−	+	+
302	−	⊖	−	−	+	+	+	+
303	+	+	+	+	−	−	−	−

Ascus								
306	−	−	−	−	+	+	+	+
308	+	+	+	+	−	−	−	−
314	+	+	+	⊕	−	−	−	−
316	−	−	−	−	+	+	+	+

P_1 Generation (4−5×6−5)I×I (*continued*)

Ascus								
317	+	+	+	+	−	−	−	−
318	+	+	+	+	−	−	−	−
320	−	−	−	−	+	+	+	+
322	−	−	−	−	+	+	+	+

Ascus								
323	+	+	−	−	−	−	+	+
(324)	−	−	−	+	−	+	+	+
325	−	−	−	−	+	+	+	+
329	−	−	−	−	+	+	+	+

14 I:2 II

F_1 Generation (Ascus 114 selfed) I selfed

(114−1×8) I selfed

158	+	+	+	+	−	−	⊖	−
159	+	+	+	+	−	−	⊖	−
160	+	+	+	+	−	−	−	−
164	⊕	⊕	+	+	−	−	−	−

4 I:0 II

(114−1×7) I selfed

Ascus								
216	−	−	−	−	+	+	⊕	⊕
217	−	−	−	−	+	+	⊕	+
218	+	+	+	+	−	−	−	−
219	+	+	+	+	−	−	−	−
(220)	−	−	−	+	−	+	+	+
221	+	⊕	+	+	⊖	−	−	−
222	+	⊕	⊖	−	+	+	−	−
223	−	−	−	−	+	+	+	+
225	+	+	+	+	−	−	−	−
(226)	+	+	+	−	+	−	−	−
224	−	⊖	−	−	+	+	⊕	+
227	⊕	+	+	+	−	⊖	−	−
228	−	−	−	−	+	+	+	+
229	+	+	+	+	−	−	−	−
230	−	−	−	−	+	+	+	+
231	−	−	+	+	+	+	−	−
232	−	−	−	−	+	⊕	+	+
233	−	−	−	−	+	+	+	+
234	+	+	−	−	+	+	−	−
(235)	+	+	+	−	+	−	−	−
236	−	−	−	−	+	+	+	+
237	+	+	+	+	−	−	−	−
238	−	−	−	−	+	+	+	+
239	+	+	−	−	+	+	−	−
240	−	−	−	−	+	+	+	+
242	+	+	+	+	−	−	−	−
243	−	−	−	−	+	+	+	+
244	+	+	+	+	−	−	−	−
248	−	−	−	−	+	⊕	+	+
249	−	−	−	−	⊕	+	+	+
251	−	−	−	−	+	⊕	+	⊕
252	+	+	−	−	−	−	+	⊕
253	+	+	+	+	−	−	−	−

Ascus								
254	−	−	+	+	+	+	−	−
255	−	⊖	−	−	+	+	+	+
257	+	+	+	+	−	−	⊖	−
258	+	+	+	+	−	−	−	−
259	−	−	−	−	+	+	+	+
263	−	−	−	−	+	+	+	+
264	−	−	−	−	+	+	+	+
265	−	−	−	−	⊕	+	+	+
266	+	+	+	+	−	−	−	−
267	+	+	+	+	−	−	−	−
268	−	−	−	−	+	⊕	+	+
271	−	−	−	−	+	+	+	+
273	+	+	+	⊕	−	−	⊖	⊖
274	−	−	−	−	+	+	+	+
275	−	−	−	−	+	+	+	+
276	−	−	−	−	+	+	+	+
277	+	+	+	+	−	−	−	−
278	+	+	+	+	−	−	−	−
280	+	+	−	⊖	−	−	+	+
281	−	−	−	−	+	+	+	+
282	+	+	+	+	−	−	−	−
284	+	⊕	+	+	−	−	−	⊖
285	⊖	−	−	−	+	+	⊕	+
286	−	−	−	−	⊕	+	+	+
288	−	−	−	−	+	+	⊕	+
289	+	+	−	−	−	−	+	+
290	⊕	⊕	−	−	⊕	+	−	−
291	−	−	−	−	+	+	+	+
292	+	+	+	+	−	−	−	−

53 I:9 II

TABLE 2 (*continued*)

F_2 Generation

(223−1×230−6)I×I

Ascus

	331	−	−	−	−	+	⊕	+	+
	332	+	+	⊕	+	−	−	⊖	−
	333	+	+	⊕	+	−	⊖	−	−
335	335	−	−	−	−	+	+	+	+
	336	−	−	+	+	+	+	⊖	−
	337	+	+	−	−	−	−	+	+
	338	−	−	+	+	+	+	−	−
	339	−	−	−	⊖	+	+	⊕	⊕
	340	⊕	+	+	+	−	−	−	−
	341	+	+	+	+	−	−	−	−
	343	⊕	+	+	+	−	−	−	−

8 I:3 II

(223−7×229−8)I×I

Ascus

	345	−	−	−	−	+	+	+	+
	346	−	−	−	−	+	+	+	+
	347	+	+	+	+	⊖	−	−	−
349	(348)	+	−	+	−	+	+	−	−
	(349)	−	−	⊖	+	−	+	+	+
	350	+	+	+	+	−	−	−	−
	351	+	+	−	−	−	−	+	+
	352	−	−	−	−	+	+	+	+
	353	−	−	−	−	+	+	+	+
	354	⊖	−	⊖	−	+	+	+	+
	355	+	+	+	+	−	−	−	−
	356	−	−	⊖	−	+	+	+	+
	357	−	−	−	−	+	+	+	+
	358	⊕	+	+	+	−	−	−	−
	359	−	−	−	−	+	+	+	+
	360	−	−	+	+	+	+	−	−
	362	−	−	−	−	+	⊕	+	⊕

14 I:3 II

(160−1×8)I selfed

Ascus

	(493)	⊖	−	−	+	−	+	+	+
	494	−	−	−	−	+	+	+	⊕
	496	−	−	⊖	⊖	⊕	+	+	+
	498	⊖	−	−	−	+	⊕	+	+
	500	−	−	−	−	+	+	+	+
	502	+	+	⊕	+	−	−	−	−
	503	+	+	+	+	−	−	−	−
504	504	+	+	+	+	−	−	−	−
	505	−	−	−	−	+	+	+	+
	506	⊕	+	−	−	+	+	−	−
	507	−	−	−	−	+	⊕	+	+
	508	−	−	−	−	+	+	+	+
	509	+	+	+	+	−	−	⊖	−
509	510	+	+	+	+	−	−	−	⊖
	511	⊖	−	⊖	−	+	+	+	+
	512	−	−	−	−	+	+	+	+
	513	+	+	+	+	−	−	−	−
	514	+	+	+	+	−	−	−	−
	515	+	+	+	+	−	−	−	−
517	518	⊕	+	+	+	−	−	−	⊖
	519	−	−	−	−	+	+	+	+
	520	−	−	−	−	⊕	+	+	+

21 I:1 II

(226−1×6) I selfed

Ascus

450	+	⊕	+	+	−	−	−	−
452	+	+	+	+	⊖	⊖	−	−
453	+	+	+	+	−	−	−	−
459	+	+	+	⊕	⊖	−	−	−
466	+	+	+	+	−	⊖	−	−
467	+	+	+	+	−	−	−	⊖

6 I:0 II

F_2 Generation

(243−2×5) I selfed

Ascus

364	364	−	−	−	−	+	+	+	+
	365	+	+	+	+	−	−	−	−
	366	−	−	−	−	+	+	+	+
	367	−	−	−	−	+	+	+	+
	368	+	+	−	−	+	+	−	−
	369	−	−	−	−	+	+	+	+
	370	−	−	+	+	−	−	+	+
	372	+	+	+	+	−	−	−	−

Ascus

373	373	−	−	−	−	+	+	+	+
	374	+	+	+	+	−	−	−	−
	375	−	−	−	−	+	+	+	+
	376	−	−	−	−	+	⊕	+	+
	377	−	−	−	−	+	+	+	+
	(378)	−	−	−	+	−	+	+	+

12 I:2 II

(273−3×290−3) I×II

569	569	−	−	−	−	⊕	+	⊕	+
	570	+	+	+	+	−	−	−	−
571	571	+	+	−	−	+	+	−	−
	572	+	+	+	+	−	⊖	−	−
	573	−	−	−	−	+	⊕	⊕	+
573	574	⊖	⊖	⊕	+	−	−	+	⊕
	575	⊕	+	+	⊕	⊖	⊖	−	−
	576	+	+	+	+	−	−	−	−
	577	+	+	+	+	−	−	−	−
577	578	−	−	−	−	+	+	+	+
	579	+	+	+	+	−	−	−	−
	580	−	−	−	−	+	+	+	+
581	581	−	−	−	−	+	+	+	+
	582	−	−	−	−	+	+	+	+
	583	−	−	−	−	+	+	+	+
583	584	+	+	+	+	−	−	−	⊖
	585	−	−	−	−	+	+	+	+

15 I:2 II

(288−5×290−7) I×II

	548	−	−	−	−	⊕	+	+	+
546	549	−	−	⊖	−	⊕	+	+	⊕
	550	−	−	+	+	+	+	−	−
551	551	−	−	⊖	⊖	+	+	+	+
	552	+	+	+	+	−	−	−	−
553	553	+	+	+	+	−	−	−	−
	554	+	+	+	+	−	−	−	−
	555	−	−	−	−	+	+	+	+
555	556	−	−	−	−	+	+	+	⊕
	557	−	−	−	−	+	+	+	+
558	558	+	+	+	+	−	−	−	−
	559	+	+	+	+	−	−	−	−
	561	−	−	−	−	+	+	+	+
560	562	−	−	−	⊖	+	+	+	+
	(564)	⊕	⊕	+	−	+	−	−	−
	567	−	−	−	−	+	+	+	+

15 I:1 II

F_3 Generation

(337−6×7) II selfed

Ascus

379	+	+	+	+	−	−	−	−
380	−	−	−	−	+	+	+	+
381	−	−	−	−	+	+	+	+
382	+	+	−	−	−	−	+	+
383	+	+	+	+	−	−	−	−
384	−	−	−	−	+	+	+	+

5 I:1 II

(337−2×3) II selfed

Ascus

385	−	−	+	+	+	+	⊖	−
386	+	+	+	+	⊖	−	−	−
387	−	−	−	−	+	+	+	+
388	−	−	+	+	+	+	−	−
389	−	−	−	−	+	+	+	+
390	−	−	−	−	+	⊕	+	+

4 I:2 II

(338−6×7) II selfed

Ascus

470	470	+	+	+	+	−	−	−	⊖
	471	−	−	−	⊖	+	+	+	+
	473	−	−	−	⊖	+	+	+	+
473	474	−	−	−	⊖	+	+	+	+
	475	+	+	⊕	+	⊖	−	−	−
	476	+	+	+	+	−	−	⊖	−
	477	−	−	−	−	+	+	+	⊕
477	478	−	−	+	+	+	+	−	−
	479	⊕	⊕	+	+	−	−	−	−
	480	−	−	−	−	+	+	+	+
	481	−	−	−	−	+	+	+	+
480	482	−	−	+	+	+	+	−	−
	483	−	−	−	−	+	+	⊕	+
	484	−	−	⊖	−	+	+	+	+
486	486	−	−	−	−	+	+	+	+
	487	+	+	⊕	+	−	−	−	−
	488	−	−	−	−	+	+	+	+
488	489	−	−	−	⊖	+	+	+	+
	490	−	−	−	−	+	+	+	+

17 I:2 II

(338−2×3) II selfed

Ascus

	524	−	−	−	−	+	+	+	+
525	525	−	−	+	+	−	−	+	+
	526	+	+	+	+	−	−	−	−
	527	+	+	+	+	−	−	−	−
528	528	−	−	−	−	+	+	+	+
	529	−	−	−	−	+	+	+	+
	530	+	+	+	+	−	−	−	−
	531	+	+	+	+	−	−	−	−
532	532	⊖	−	+	+	−	−	+	+
	533	+	+	+	+	−	−	−	−
	534	−	−	−	−	+	+	+	+
534	535	+	+	+	+	−	−	−	−
	536	−	−	⊖	−	+	+	+	+
	537	+	+	+	+	−	−	−	−
540	540	+	+	+	⊕	−	−	−	−
	541	−	−	−	−	+	+	+	+
	543	⊖	−	⊕	+	+	+	−	⊖
	544	+	+	+	+	−	−	−	−

15 I:3 II

the ascospores. Ascus 226 is a case in point. The arrangement of the ascospores of different sex, shown in table 2 (for ascus 226), indicates a shift in positions 4 and 5. The arrangement of the spores producing different types of mycelia as shown in table 3 confirms the fact that this is merely shifting of the nuclei. It is clear that tan and Normal factors are segregated independently of the sex factors, yet the same peculiar arrangement of the

TABLE 3

Sex and cultural characters of ascospores in Ascus 226.

ASCOSPORES	1	2	3	4	5	6	7	8
Sex.....	+	+	+	−	+	−	−	−
Character.....	N	N	t	N	t	N	t	t

fourth and fifth spores in ascus 226 holds for the tan- and Normal-producing spores as well as for the spores of opposite sex. Reversing the fourth and fifth spores, gives a simple first-division segregation of the sex factors and a second-division segregation of the factors for tan and Normal. Two other exceptions, which cannot be readily interpreted on this basis, are asci 1 and 10. These were dissected before the writer became expert enough to be certain of his technique.

To date no evidence has been obtained of segregation of any factors at the third division in the ascus. Text figure 2, c is a diagram of a hypothetical ascus, which would be evidence for a third-division segregation, if encountered. No such ascus has been discovered.

In order to facilitate discussion, from this point on, some abbreviations will be used. In making matings, individual ascospores were planted in separate tubes on nutrient agar until mycelia and conidia appeared. Then some of the mycelia and conidia from two tubes were planted into a third tube. Strictly speaking, of course, matings were made between clones produced by ascospores, and not between the ascospores. However, from now on, such matings as that which produced the P_2 generation will be described as follows: Ascospore 0–1 was mated to ascospore 0–8, or, more briefly: 0–1×0–8 (I selfed). The expression in parentheses is a second convention indicating that the mating was made between mycelia produced by ascospores from the same ascus (selfed) and that segregation of the sex factors occurred at the first division (I).

Ascus 0, shown in table 2, is the parent ascus of all the *N. crassa* ascospores studied. From the P_2 generation, which was produced by a I selfed mating (0–1×0–8), six asci were dissected. In four of these asci, the sex factors were segregated at the first division, and, in two of them, they

were segregated at the second division. Stated briefly: the P_2 generation produced by a I selfed mating contained four I and two II. This is 67 per cent I.

The four groups in the $P_2 \times P_3$ back-cross generation contained 79, 80, 80, and 75 per cent I respectively. The first two groups were produced by a I×I mating, and the second two groups by a I×II mating.

It is evident in this and the succeeding generations (perithecia 124, 218, 230, 233, 239, 251, and 277) that first- and second-division segregation of sex may occur in asci side by side in the same perithecium.

TABLE 4

Summary of table 2 showing the percentages of first-division segregation produced by twenty matings in seven generations.

GENERATION	TOTAL NO. OF ASCI	MATING	%-I
P_3	1		100
P_2	6	I selfed	67
$P_2 \times P_3$	19	I×I	79
$P_2 \times P_3$	5	I×I	80
$P_2 \times P_3$	5	I×II?	80
$P_2 \times P_3$	4	I×II?	75
P_1	16	I×I	88
F_1	62	I selfed	86
F_1	4	I selfed	100
F_2	11	I×I	73
F_2	17	I×I	82
F_2	22	I selfed	96
F_2	14	I selfed	86
F_2	6	I selfed	100
F_2	16	I×II	94
F_2	17	I×II	88
F_3	6	II selfed	83
F_3	19	II selfed	90
F_3	6	II selfed	67
F_3	18	II selfed	83
			MEAN 85%-I

Table 4 summarizes the data in table 2. It is apparent that the three types of matings. (I×I, I×II, and II×II) give approximately the same percentage of I. The mean of the total 275 asci is 85 per cent I, and the percentages obtained in the II×II matings vary no more from this mean than those obtained by the I×I matings.

Table 5 illustrates this point. All of the matings are grouped into their three different classes. I×I produced 85 per cent I; II×II produced 84 per cent I; and I×II produced 88 per cent I. In order to determine if the deviation of the I×II and the II×II matings from the I×I matings was

significant, the ratio of the deviation to the probable error was determined. Deviations were calculated from the 85 per cent obtained in the 182 I×I asci. It is obvious that this ratio is much less than 3, which is generally accepted as indicating significance.

TABLE 5

Data in table 4 arranged to show the percentage of first-division segregation produced by all the I×I I×II, and II×II matings.

MATING	NUMBER OF ASCI SHOWING FIRST-DIVISION SEGREGATION	NUMBER OF ASCI SHOWING SECOND-DIVISION SEGREGATION	PERCENTAGE OF FIRST-DIVISION SEGREGATION	$\frac{d}{P.E.}$
I×I	155	27	85	
I×II	37	5	88	.81
II×II	41	8	84	.30

The best test for the possibility of genic factors regulating the type of segregation is selection and subsequent crossing. Table 6 gives the results of six generations of selection for first-division segregation. It may be seen from the table that even after six generations of I×I matings, the percentage of first-division segregation is not increased.

TABLE 6

Results of selections for first-division segregation carried on through six generations.

GENERATION	NUMBER OF ASCI	PERCENTAGE OF FIRST-DIVISION SEGREGATION	MATING
P_3	1		
P_2	6	67	(0–1×0–8)(I selfed)
P_{2x3}	19	79	(0–1×6–2)(I×I)
P_1	16	88	(4–5×6–5)(I×I)
F_1	62	86	(114–1×7)(I selfed)
F_2	17	82	(223–7×229–8)(I×I)

Therefore, there is established this definitive numerical datum: The sex factors are segregated at the first division of the ascus nucleus in 85 per cent of the asci of *Neurospora crassa* and at the second division of the ascus nucleus in 15 per cent of the asci. This applies to the asci containing eight ripe spores. These percentages are constant regardless of whether the sex factors had been segregated at the first or second division in either or both parents. It is not possible by selection to increase or diminish these percentages. Thus the type of segregation obtained cannot be directly attributed to the effect of genic factors.

On the basis of pure chance, four types of II should occur with equal

frequency. Table 7 shows the frequency of each one of the four types encountered in the forty II obtained. There are 26 cases in which four like

TABLE 7

Frequency distribution of the four possible types of second-division segregation.

TYPE OF II	FREQUENCY
− − + + + + − −	16
+ + − − − − + +	10
+ + − − + + − −	9
− − + + − − + +	5

nuclei are grouped in the center of the ascus as compared with the 14 cases in which the like nuclei are arranged by twos in the ascus.

SEX AND ARRANGEMENT OF THE SPORES IN THE ASCUS OF NEUROSPORA SITOPHILA

Fifteen asci of *N. sitophila*, from three consecutive generations, were studied. Table 8 shows the sex and arrangement of spores in these asci. From ascus 89, in which the sex factors had been segregated at the first

TABLE 8

Sex and arrangement of the ascospores in fifteen asci of N. sitophila.

First generation

Ascus

89 + + − − − − + +

Second Generation

89−1×4

Ascus

26 ⊖ ⊖ + + ⊖ ⊖ + ⊕

29 − − + ⊕ ⊕ + − −

30 ⊕ + + + ⊖ ⊖ − ⊖

31 ⊕ ⊕ + + ⊖ − ⊖ −

32 + + + ⊕ − ⊖ ⊖ ⊖

34 ⊖ ⊖ + ⊕ + + − −

35 + + + + − ⊖ ⊖ ⊖

40 ⊕ + + + − − − −

5 I:3 II

Third Generation

40−2×8

Ascus

203 + + + + − − − −

204 − − + + − − + +

205 + + + + − − − −

207 + + + + − − − −

209 + + − − + + − −

210 + + − − − − + +

3 I:3 II

division, a second generation was produced by mating the mycelia from the first and fourth ascospores. Eight asci from this generation were studied. In five of these asci the sex factors had been segregated at the first division, and in three of them they had been segregated at the second division in the ascus.

From ascus 40, in which the sex factors were segregated at the first division, a third generation was produced. In three of the third generation

asci, the sex factors were segregated at the first division, and in three others the sex factors were segregated at the second division.

In other words, matings between spores from an ascus in which the sex factors had been segregated at the first division produced both first- and second-division offspring. Moreover, matings between spores from an ascus in which the sex factors had been segregated at the second division also produced both first- and second-division offspring. This is in agreement with the data already reported in the case of *N. crassa*. An insufficient number of asci was tested to ascertain if the ratio of first- to second-division segregation was constant.

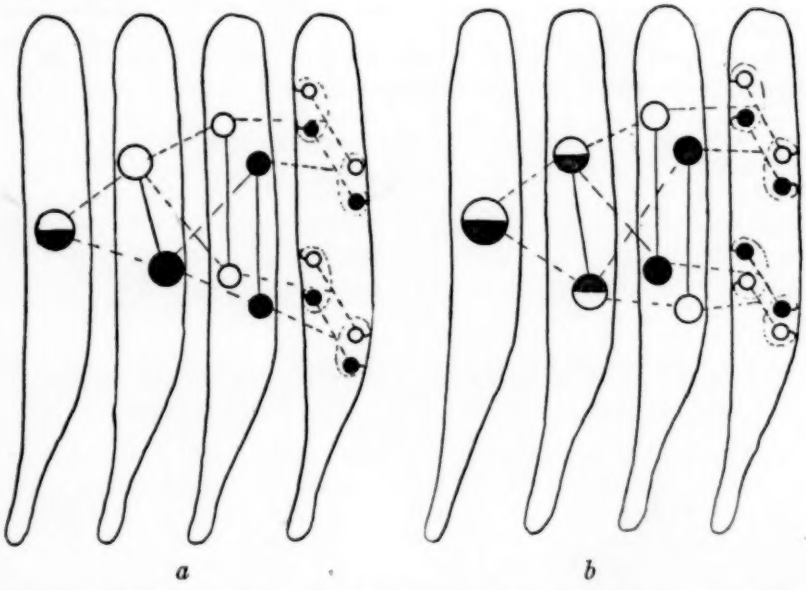


Fig. 3. a. Orientation of the spindles in the ascus of *N. tetrasperma*, as described by Dodge, and the resultant production of four bisexual spores following first-division segregation of the factors for sex. b. Diagram showing the orientation of nuclei necessary to produce four bisexual spores in the ascus of *N. tetrasperma*, following second-division segregation of the sex factors.

SEX AND ARRANGEMENT OF THE SPORES IN THE ASCUS OF NEUROSPORA TETRASPERMA

Dodge (1927) has described very carefully the orientation of the spindles in the ascus of *N. tetrasperma*. Text figure 3 summarizes his findings. It is obvious that segregation of the sex factors at the first division in the ascus would invariably produce the four bisexual spores usually found. Text figure 3, b, shows that a second-division segregation of the sex factors could produce the same result if the tetrads in the binucleate stage were

oriented in the particular manner shown. Text figure 4 shows some of the possibilities if the tetrads were oriented in the opposite way.

Dodge has shown that not all of the asci of *N. tetrasperma* contain four spores. He has described many abnormal asci and found that the number of spores in an ascus may vary from one to six. The writer has also found asci containing seven and eight spores. Text figure 5 shows the sex and arrangement of the spores in 14 five- and six-spored asci. Large circles designate large spores and small circles designate small spores. Plus and minus signs indicate the respective sexes, while a circle containing both a plus and a minus sign indicates a bisexual spore. A question mark indicates that the respective spore did not germinate, and consequently its sex was not discovered. But it was occasionally possible to ascertain its sex from the known fact that four nuclei of each sex are formed in each ascus. In the case of asci 119 and 134, two alternative possibilities are suggested.

In the five-spored asci, the two small spores were of opposite sex. In asci 91, 97, and 106, these small spores were probably formed because the two adjacent nuclei of opposite sex were too far apart to be incorporated into a single spore. Each unisexual nucleus formed a spore wall about itself. Dodge's cytological work has shown that a beak is produced at the tip of each nucleus. This beak is curved at the end like an umbrella handle and probably has its origin in the central body or the astral rays. When the beaks of two adjacent nuclei are close enough together, these nuclei are included within a single large spore.

In asci 92, 98, 102, 107, 108, and 95, a different arrangement of the spores was found. The two small unisexual spores were separated by a single large bisexual spore. It appears that when the eight unisexual nuclei were formed in the ascus (see fig. 3, a), instead of unisexual nuclei 5 and 6 uniting to form the third bisexual spore, and unisexual nuclei 7 and 8 uniting to form the fourth bisexual spore, an unusual combination took place. In these cases, nuclei 6 and 7 were so placed that they were more easily incorporated into a single bisexual spore with each other than with their normal partners. This was probably because the two beaks were so situated with regard to each other that a single ascospore was cut out. This left nuclei 5 and 8 alone, and each made a single unisexual spore. The linear arrangement of the spores in the ascus, as a result of first-division segregation of the sex factors would result in nuclei 5 and 8 being of opposite sex. Nuclei 6 and 7 would also be of opposite sex and their incorporation into a single large spore would make a bisexual spore.

No explanation has yet been evolved for the fact that when a five-spored ascus of the type of ascus 92 is found, it is usually the nuclei at the base of the ascus that participate in the abnormal arrangement. Six-

spored asci 104 and 155 show that the upper four nuclei are capable of undergoing such an abnormal arrangement as well. Nuclei 2 and 3 (fig. 3, a), as well as nuclei 6 and 7, united to form bisexual spores, leaving unisexual nuclei 1, 4, 5, and 8 to form individual spores. The failure of nuclei 4 and 5 to form a single bisexual spore is interesting, for they are close to each other and of opposite sex. It is probably the orientation of the beaks which prevents the formation of a single bisexual spore in these cases. Text figure 3, a, shows that nuclei 4 and 5 are usually found with their beaks pointing in opposite directions. Each one cuts out a single unisexual spore. These findings confirm the view that opposite orientation of the beaks is a most im-

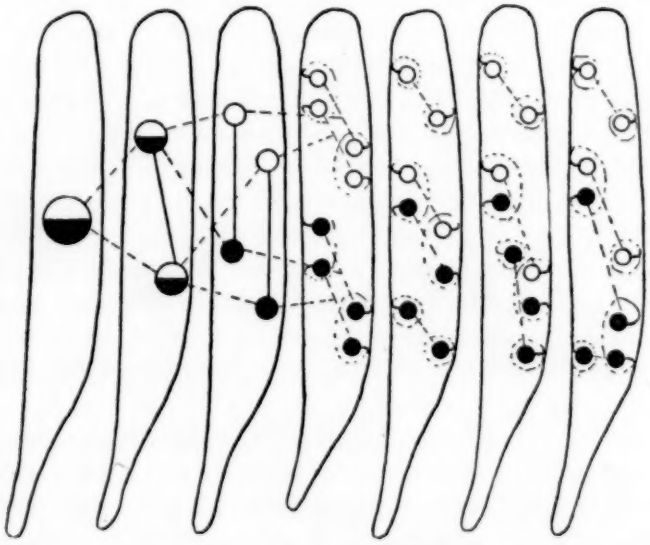


Fig. 4. Diagram showing some of the results that might be expected if segregation of sex factors occurred at the second division in the ascus, with the nuclei oriented opposite to the manner shown in figure 3, b.

portant factor in preventing two adjacent nuclei of opposite sex from forming a single bisexual spore. (Further evidence of this nature is given by asci 119, 134, and 154, in which unisexual nuclei 2 and 5 (fig. 4) apparently unite to cut out one large bisexual spore.)

All of the above described asci are easily referred to the diagrams in text figure 3, a (adapted from Dodge, 1927). These all show the result of first-division segregation of the sex factors. However, asci 119, 134, and 154 cannot be referred to this scheme. They are more easily explained as arrangements which might result from second-division segregation of the sex factors. Text figures 3, b, and 4 show two possibilities of second-division

segregation. The former is identical to that resulting from first-division segregation. The latter arrangement is equally likely to occur, if the orientation of the chromosomes in the binucleate stage in the ascus is the result of pure chance. An extended discussion can be avoided if the reader compares the asci 119, 134, and 154 with the scheme and arrangements shown in text figure 4. In spite of the fact that the sex of some of the spores was not determined, it seems clear that, in these asci, the sex factors were segregated at the second division.

In this strain of *N. tetrasperma*, there was a striking difference in the cultural characters of the mycelium produced from unisexual spores of

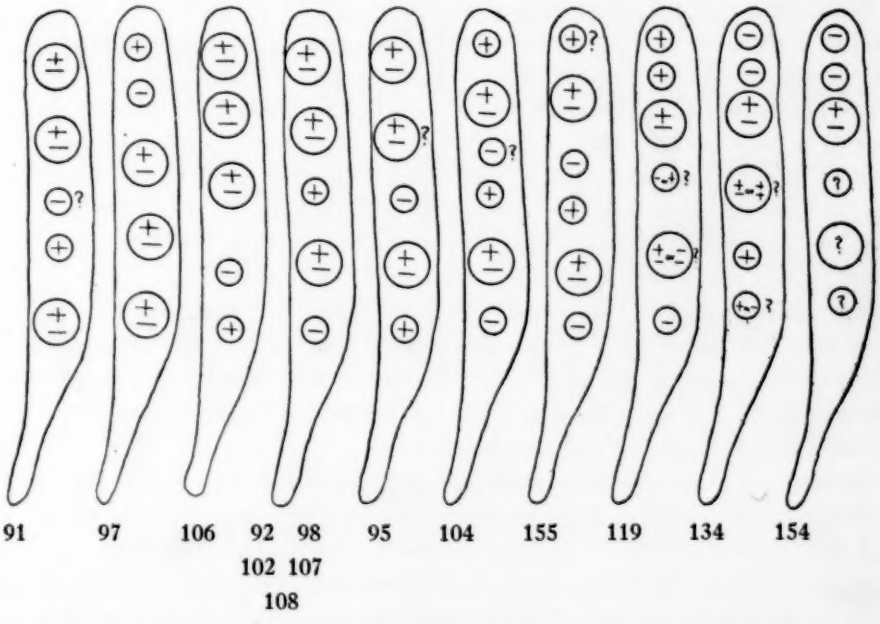


Fig. 5. Sex and arrangement of the spores in 14 abnormal asci of *N. tetrasperma*.

opposite sex. One sex produced abundant orange conidia and no color in the substrate. The other sex produced only a few white conidia and a dark, almost black, substrate.

In asci 119, 134, and 154 unisexual nuclei 1 and 2 were of the same sex and near to each other, and their beaks were probably oriented together. The fact that they did not form a single unisexual spore seems to indicate that nuclei of opposite sex cooperate in this process more readily than those of like sex. However, it is not impossible for two nuclei of like sex to form a large spore, for Dodge and the writer have both found large unisexual spores.

DISCUSSION

It has been demonstrated, in the case of *Neurospora crassa*, that the sex factors were segregated only at the first two divisions in the ascus. The ratio of first- to second-division segregation was 85 to 15. In view of this fact, it is interesting to note that both first- and second-division segregation of the sex factors occurred in *N. tetrasperma*. But first-division segregation was more frequent, as in the case of *N. crassa*. This is shown by the preponderance of asci containing four bisexual spores. It is possible, as Dodge points out, to obtain four bisexual spores by first-, second-, or third-division segregation of the sex factors. But in the case of second- or third-division segregation, the arrangement of the chromosomes would have to be determined by some means other than pure chance. In the case of second-division segregation of the sex factors of *N. crassa*, the writer has shown that there are four possibilities. Table 8 shows that, in spite of a very questionable preference for a certain orientation, all four possible orientations were found. This is an indication that, in *N. crassa*, the data do not eliminate pure chance as determining the orientation of the chromosomes on the spindle. In view of these data and the generally accepted fact that the chromosomes are oriented on the meiotic spindle by chance, as is proved in the case of *Drosophila*, it seems reasonable to assume that the orientation of the chromosomes of *N. tetrasperma* is also determined largely, if not wholly, by chance. If this is the case, the preponderance of asci with four bisexual spores means a preponderance of first-division segregation of the sex factors.

In the case of *N. sitophila*, sufficient data have not been accumulated to determine the ratio of first- to second-division segregation, or to show that this ratio is constant. But it has been shown that both first- and second-division segregations occur. It seems very likely, in view of the evidence so far obtained, that, in *N. tetrapserma* and *N. sitophila*, it will be found, on subsequent investigation, that there is a constant ratio of first- to second-division segregation of the sex factors. It will be interesting to know if this ratio is 85 to 15 as in the case of *N. crassa*.

SUMMARY

1. It has been shown that segregation of the sex factors may occur at either the first or second division in the ascus of *Neurospora crassa*.

2. Segregation of the sex factors at the third division in the ascus of *N. crassa* has not been found.

3. The ratio of first- to second-division segregation of the sex factors is 85 to 15 in *N. crassa*. This ratio is constant, in *N. crassa*, and is not determined by genic factors.

4. Both first- and second-division segregations of the sex factors have been found in the ascus of *N. tetrasperma*.

5. In the ascus of *N. tetrasperma* also, the sex factors are segregated more frequently at the first than at the second division in the ascus.

6. In *N. sitophila* segregation of the sex factors occurs at both the first and second division in the ascus.

7. A study of three generations of *N. sitophila* shows that spores from either type of ascus, on inbreeding, will produce both types of asci.

8. The data suggest the possibility that in all three species of *Neurospora* the ratio of asci in which the sex factors are segregated at the first division to those in which they are segregated at the second division is constant and cannot be modified by selection.

9. The question as to whether this ratio is the same in all three species is raised.

This work was begun at the suggestion of Professor T. H. Morgan, and it is his interest and support which have made it possible to continue the study. The writer wishes to express his thanks for criticism of the manuscript to Doctor Morgan and to Dr. B. O. Dodge, whose careful cytological work on the orientation of the spindles in the asci of the three species of *Neurospora* paved the way to interpretation of the data of this study.

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A discussion of tautonyms

HAROLD N. MOLDENKE

A rather unnecessary problem in botanical nomenclature has arisen in recent years. Although the repetition of a generic name as a specific name within that genus has always been forbidden by the international rules of nomenclature, yet a great many such combinations (known technically as tautonyms) have appeared in various botanical works during the last half century. In some cases the results of the use of these combinations have not been especially confusing, for even an amateur botanical student on seeing such combinations as *Linaria Linaria*, *Hystrix Hystrix*, *Catalpa Catalpa*, *Malus Malus*, and *Sassafras Sassafras* knows that *Linaria vulgaris*, *Hystrix patula*, *Catalpa bignonioides*, *Malus sylvestris*, and *Sassafras variifolium* are the plants which the writer has in mind. In some cases, however, where an old genus is divided to form one or more new genera (like, for example, *Polygonum* and *Persicaria*), the result is more unfortunate. One may heartily approve of the segregation of the new genus, but one may be faced with a combination in this new genus (as, for instance, *Persicaria Persicaria*) which is a violation of the rules and which one therefore does not wish to use. Often it happens that the only other name for such a plant in common use or to be found in the more popular handbooks and manuals is one in the original genus (as in the case of *Persicaria Persicaria*, the only other name for which to be found in the average handbook or manual being *Polygonum Persicaria*). The botanist, therefore, who does not have the facilities for making extensive researches into botanical literature, is faced with the alternative of either using a name in the new genus which he knows to be against the rules or not accepting the newly segregated genus at all and continuing to use the old generic name for species which he personally feels ought to be segregated. It is in the hope of being able to be of some assistance to any who may be faced with such a problem as this that the following notes have been prepared.[1]

"Double binomials" or tautonyms are more numerous in botanical literature than is commonly supposed—228 being recorded in the following list. All except six of these were published during the last fifty-two years—83 having appeared in the decade of 1880–89, 87 in the decade of 1890–99, 29 in the decade of 1900–09, 20 in the decade of 1910–19, and 9 in the decade of 1920–29. The remaining six, however, are surprising in that they date back from 58 to 163 years—one having appeared in 1873, one in 1851,

[1] The writer wishes to express his deep appreciation and thanks to Dr. John Hendley Barnhart, who has kindly assisted in the assembling of these nomenclatural notes.

one in 1829, one in 1812, and two in 1768. The botanists responsible for these names are thirty-six in number, and their names are given in the following table as well as the number of tautonyms herein accredited to each.

Karsten....86	Sargent....3	Dörfler....1
Huth....28	Hill....2	Griggs....1
Britton....26	Wettstein....2	Jirasek....1
Voss....18	W. F. Wight....2	Kerner....1
MacMillan.... 9	Barnhart....1	Keyserling....1
Small.... 9	Beauvois....1	Kuntze....1
Millspaugh.... 7	Borbás....1	Maxon....1
Cockerell.... 6	Britton & Rose....1	Murrill....1
Druce.... 5	Christ....1	Nash....1
Lyons.... 5	Coulter....1	Newman....1
Ascherson & Graebner. 4	Degen....1	Nieuwland....1
Rydberg....4		Rusby....1

Many of the botanists, however, who are herein credited with the publication of new tautonyms published many more such duplicate combinations than are here accredited to them. This was due to their almost universal ignorance of, or at least unfamiliarity with, the works of the other men in this field, causing each to suppose that the combination which he wished to propose had never yet been published when, in reality, it had already appeared in literature often many years previous. Lyons, for instance, in his "Plant Names" published over twenty tautonyms as new, when in reality all but five had already appeared in earlier works of other botanists. MacMillan in 1892 published *Eragrostis Eragrostis*, *Nelumbo Nelumbo*, *Phragmites Phragmites*, and *Taraxacum Taraxacum* as new combinations, apparently entirely ignorant of the fact that Karsten had published all of these tautonyms in his "Deutsche Flora" in 1880–83, while Karsten, in turn, overlooked the fact that Beauvois had published the first of these as far back as 1812! A great many of the combinations in the following list are either not at all recorded in the "Index Kewensis" or its supplements, or are therein inaccurately accredited, thus greatly adding to the present confusion as to the correct authorities for certain of these names. The combination *Abies Abies*, for instance, is accredited in the "Index Kewensis" (Suppl. 7. 1929) to Druce in 1925, while in reality it was published by Rusby thirty-three years earlier. In the following list a special effort has been made to trace each name back to its original source of publication. Names like *Epipogum Epipogium*, *Atamasco Atamosco*, *Ananassa Ananas*, *Carum Carui*, *Sesbania Sesban*, *Sebesten Sebestena*, etc., which are not tautonyms in the strict interpretation of this term are not here considered.

The only other list of tautonyms which makes any pretense of being exhaustive to be found in botanical literature is that of Huth in "Helios" (**11**:132–136. 1893) wherein are listed 117 of these combinations. His list, however, is obsolete now because of the many new tautonyms which have been published since 1893. It is also incomplete for the period up to 1893 and contains many errors. The names given as the oldest in the segregated genera in at least 18 cases are incorrect—there being older valid ones in each case—while a number of such common combinations as *Hepatica triloba*, *Libanotis montana*, *Linaria vulgaris*, and *Rocella tinctoria* are incorrectly accredited. No specific references are made to the exact place of publication of the names cited. Still another error is the statement that the publication of tautonyms is primarily a practice of North American botanists—an opinion which is said to be widespread among European botanists even at the present time. A glance at the table given above will show that 16 of the 36 botanists there mentioned where Europeans and published 154 of the 228 tautonyms herein cited.

ABELMOSCHUS ABELMOSCHUS (L.) Karst. Fl. Deutschland, ed. 2, **2**: 157. 1895.
= *Abelmoschus moschatus* Medic. Malv. 46. 1787.

ABIES ABIES (L.) Rusby, Bull. Pharm. **6**: 310. 1892.
= *Abies excelsa* Poir. Encyc. **6**: 518. 1804.

ABRUS ABRUS (L.) W. F. Wight, Contrib. U. S. Nat. Herb. **9**: 171. 1905.
= *Abrus precatorius* L. Syst., ed. 12, 472. 1767.

ABUTILON ABUTILON (L.) Huth, Helios **11**: 132. 1893.
= *Abutilon Theophrasti* Medic. Malv. 28. 1787.

ACINOS ACINOS (L.) Huth, Helios **11**: 132. 1893.
= *Acinos thymoides* Moench, Meth. 407. 1794.

ACISANTHERA ACISANTHERA (L.) Britton, Sci. Surv. P. R. & Virgin Isls. **6**: 2. 1925.
= *Acisanthera quadrata* Juss. ex Poir. in Lam. Encycl. Suppl. **1**: 111. 1810.

ADHATODA ADHATODA (L.) Huth, Helios **11**: 132. 1893.
= *Adhatoda vasica* Nees in Wall. Pl. As. Rar. **3**: 103. 1832.

AEGINETIA AEGINETIA (L.) Huth, Helios **11**: 132. 1893.
= *Aeginetia indica* L. Sp. Pl. 632. 1753.

ALHAGI ALHAGI (L.) Huth, Helios **11**: 132. 1893.
= *Alhagi maurorum* Medic., Vorles. Churpf. Phys. Ges. **2**: 397. 1787.

ALLIARIA ALLIARIA (L.) Huth, Helios **11**: 132. 1893.
= *Alliaria officinalis* Andrz. in DC. Reg. Veg. Syst. **2**: 489. 1821.

ALNUS ALNUS (L.) Britton in Britton & Br. Ill. Fl., ed. 2, **1**: 613. 1913.
= *Alnus vulgaris* Hill, Brit. Herb. 510. 1756.

AMELANCHIER AMELANCHIER (L. f.) Karst. Deutsch. Fl. 784. 1882.
= *Amelanchier vulgaris* Moench, Meth. 682. 1794.

AMPHICARPON AMPHICARPON (Pursh) Nash, Mem. Torr. Bot. Club **5**: 352. 1894.
= *Amphicarpon Purshii* Kunth, Rev. Gram. 28. 1829.

AMSONIA AMSONIA (L.) Britton, Mem. Torr. Bot. Club **5**: 262. 1894.
= *Amsonia Tabernaemontana* Walt. Fl. Carol. 98. 1788.

ANACAMPSEROS ANACAMPSEROS (L.) Aschers. & Graebn. Syn. Mitteleur. Fl. 5[1]: 429. 1915.
= *Anacampseros Thelephiastrum* DC. Cat. Hort. Monsp. 87. 1813.

ANANAS ANANAS (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 964. 1895.
= *Ananas sativus* Schult. f. in Roem. & Schult. Syst. **7**: 1283. 1830.

ANANDRIA ANANDRIA (L.) Huth, Helios **11**: 133. 1893.
= *Anandria Bellidiastrum* DC. Prodr. **7**: 40. 1839.

ANARRHINUM ANARRHINUM (L.) Druce, Rep. Bot. Exch. Cl. Brit. Isles 1924, **7**: 688. 1925.
= *Anarrhinum bellidifolium* (L.) Desf. Fl. Atlant. **2**: 51. 1800.

ANDROSAEMUM ANDROSAEMUM (L.) Huth, Helios **11**: 133. 1893.
= *Androsaemum officinale* All. Fl. Pedem. **2**: 147. 1785.

ANGUINA ANGUINA (L.) Huth, Helios **11**: 133. 1893.
= *Anguina sinensis* Mill. ex Huth, Helios **11**: 133. 1893.

ANTHRISCUS ANTHRISCUS (L.) Karst. Deutsch. Fl. 857. 1882.
= *Anthriscus vulgaris* Pers. Syn. Pl. **1**: 320. 1805.

APIOS APIOS (L.) MacM., Bull. Torr. Bot. Club **19**: 15. 1892.
= *Apios tuberosa* Moench, Meth. 165. 1794.

ARCHANGELICA ARCHANGELICA (L.) Karst. Deutsch. Fl. 843. 1882.
= *Archangelica officinalis* Hoffm. Gen. Umb. 162. 1814.

ARIA ARIA (L.) Huth, Helios **11**: 133. 1893.
= *Aria nivea* Host, Fl. Austr. **2**: 8. 1831.

ARISARUM ARISARUM (L.) Huth, Helios **11**: 133. 1893.
= *Arisarum vulgare* Targ.-Tozz., Ann. Mus. Fis. Fir. 2[2]: 67. 1810.

ARMENIACA ARMENIACA (L.) Huth, Helios **11**: 133. 1893.
= *Armeniaca vulgaris* Lam. Encycl. **1**: 2. 1783.

ARMERIA ARMERIA (L.) Karst. Fl. Deutschland, ed. 2, **2**: 489. 1895.
= *Armeria vulgaris* Willd. Enum. Hort. Berol. 333. 1809.

ARMORACIA ARMORACIA (L.) Cockerell, Univ. Missouri Studies, Ser. 2, no. 2, 130. 1911.
= *Armoracia rusticana* Gaertn. Meyer & Scherb. Fl. Wett. **2**: 426. 1800.

ARUNCUS ARUNCUS (L.) Karst. Deutsch. Fl. 779. 1882.
= *Aruncus silvester* Kostel. ex Maxim. in Hort. Pet. **6**: 169. 1879.[2]

BALSAMINA BALSAMINA (L.) Huth, Helios **11**: 133. 1893.
= *Balsamina hortensis* Desp., Dict. Sc. Nat. **3**: 485. 1816.

BALSAMITA BALSAMITA (L.) Rydb., N. Am. Fl. **34**: 238. 1916.
= *Balsamita major* Desf., Act. Soc. Hist. Nat. Paris **1**: 3. 1792.

BAMBUSA BAMBUSA Huth, Helios **11**: 133. 1893.
= *Bambusa Bambos* (L.) Druce, Rep. Bot. Exch. Cl. Brit. Isles 1916, 608. 1917.

BARBAREA BARBAREA (L.) MacM. Metasp. Minn. 259. 1892.
= *Barbarea vulgaris* R. Br. in Ait. Hort. Kew., ed. 2, **4**: 109. 1812.

BATATAS BATATAS (L.) Karst. Deutsch. Fl. 973. 1882.
= *Batatas edulis* Choisy, Conv. Or. 53. 1834.

BELLIDIASTRUM BELLIDIASTRUM (L.) Karst. Deutsch. Fl. 1066. 1883.
= *Bellidiastrum Mitchelii* Cass., Dict. Sc. Nat. **4**: 70. 1816.

[2] This name is accredited by most authors to Kosteletzky in "Ind. Hort. Prag. 15. 1844" where it appears as a *nomen nudum*. The name was not validly published until 1879 when Maximowicz accompanied Kosteletzky's *nomen nudum* with a description and list of synonymy.

BENZOIN BENZOIN (L.) Coulter, Mem. Torr. Bot. Club **5**: 164. 1894.
= *Benzoin aestivale* (L.) Nees, Syst. Laur. 495. 1836.

BERNARDIA BERNARDIA (L.) Millsp., Field Columb. Mus. Bot. **2**: 58. 1900.
= *Bernardia carpinifolia* Griseb. Fl. Brit. W. I. 45. 1864.

BEURERIA BEURERIA (Willd.) Huth, Helios **11**: 133. 1893.
= *Beureria succulenta* Jacq. Enum. Pl. Carib. 14. 1760.

BIHAI BIHAI (L.) Griggs, Bull. Torr. Bot. Club **31**: 445. 1904.
= *Bihai borinquena* Griggs, Bull. Torr. Bot. Club **31**: 445. 1904.

BLECHUM BLECHUM (L.) Millsp., Field Columb. Mus. Bot. **2**: 100. 1900.
= *Blechum pyramidatum* (Lam.) Urb. in Fedde, Repert. **15**: 323. 1918.

BLEPHARIGLOTTIS BLEPHARIGLOTTIS (Willd.) Rydb. in Britton Man. 296. 1901.
= *Blephariglottis albiflora* Raf. Fl. Tellur. **2**: 38. 1836.[3]

CAJAN CAJAN (L.) Huth, Helios **11**: 133. 1893.
= *Cajanus flavus* DC. Cat. Hort. Monsp. 85. 1813.

CAKILE CAKILE (L.) Karst. Deutsch. Fl. 663. 1882.
= *Cakile maritima* Scop. Fl. Carn., ed. 2, **2**: 35. 1772.

CALAMAGROSTIS CALAMAGROSTIS (L.) Karst. Deutsch. Fl. 378. 1881.
= *Calamagrostis lanceolata* Roth, Tent. Fl. Germ. **1**: 34. 1788.

CALAMINTHA CALAMINTHA (L.) Karst. Deutsch. Fl. 1002. 1882.
= *Calamintha officinalis* Moench, Meth. 409. 1794.

CAMPHORA CAMPHORA (L.) Karst. Deutsch. Fl. 504. 1881.
= *Camphora officinarum* Nees, in Wall. Pl. As. Rar. **2**: 72. 1831.

CANELLA CANELLA (L.) Karst. Deutsch. Fl. 626. 1882.
= *Canella alba* Murr. Syst., ed. 14, 443. 1784.

CANTHARELLUS CANTHARELLUS (L.) Karst. Deutsch. Fl. 100. 1880.
= *Cantharellus cibarius* Fries, Syst. Myc. **1**: 318. 1821.

CARAGANA CARAGANA (L.) Karst. Deutsch. Fl. 697. 1882.
= *Caragana arborescens* Lam. Encycl. **1**: 615. 1783.

CARDUNCELLUS CARDUNCELLUS (L.) Huth, Helios **11**: 133. 1893.
= *Carduncellus monspeliensium* All. Fl. Pedem. **1**: 154. 1785.

CARPINUS CARPINUS (L.) Sarg. Gard. & For. 364. 1893.
= *Carpinus japonica* Blume, Mus. Bot. Lugd. Batav. **1**: 308. 1850.

CARPOBOLUS CARPOBOLUS (L.) Karst. Deutsch. Fl. 108. 1880.
= *Carpobolus albicans* Willd. Fl. Berol. 414. 1787.

CASTANEA CASTANEA (L.) Karst. Deutsch. Fl. 495. 1881.
= *Castanea sativa* Mill. Gard. Dict., ed. 8, no. 1. 1768.

CATALPA CATALPA (L.) Karst. Deutsch. Fl. 927. 1882.
= *Catalpa bignonioides* Walt. Fl. Carol. 64. 1788.

CEDRUS CEDRUS (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 1231. 1895.
= *Cedrus Libani* Barrel. ex Loud. Arb. 2402. 1838.

CENTAURIUM CENTAURIUM (L.) W. F. Wight, Contrib. U. S. Nat. Herb. **11**: 449. 1906.
= *Centaurium umbellatum* Gilib. Fl. Lithuan. **1**: 35. 1781.

[3] The *Platanthera holopetala* of Lindley (Gen. & Sp. Orch. 291. 1835), considered synonymous with this species by Rydberg (Britton & Br. Ill. Fl., ed. 2, **1**: 557. 1913), seems on account of its suborbicular sepals, its linear and entire petals, and its lanceolate and less fringed lip, to be distinct, either as a variety (as maintained by Gray) or as a separate species (as originally claimed by Lindley).

CEREFOLIUM CEREFOLIUM (L.) Britton in Britton & Br. Ill. Fl., ed. 2, **2**: 629. 1913.
= *Cerefolium sativum* Bess. Prim. Fl. Galic. **1**: 219. 1809.
CETARACH CETARACH (L.) Newm. Phytol. App. 5, ante p. 105. 1851.
= *Cetarach officinarum* DC. in Lam. & DC. Fl. Franc. **2**: 566. 1805.
CHAMAECRISTA CHAMAECRISTA (L.) Britton, Bull. Torr. Bot. Club **44**: 12. 1917.
= *Chamaecrista Pavonis* Cass. ex Greene, Pittonia **3**: 241. 1897.[4]
CHAMOMILLA CHAMOMILLA (L.) Rydb., N. Am. Fl. **34**: 231. 1916.
= *Chamomilla patens* Gilib. Exerc. Phyt. 178. 1792.
CHLOROXYLON CHLOROXYLON (Roxb.) Huth, Helios **11**: 133. 1893.
= *Chloroxylon Swietenia* DC. Prodr. **1**: 625. 1824.
CHYTRACULIA CHYTRACULIA (L.) Millsp., Field Columb. Mus. Bot. **2**: 80. 1900.
= *Chytraculia arborea* Kuntze, Rev. Gen. Pl. 238. 1891.
CIMICIFUGA CIMICIFUGA (L.) Karst. Deutsch. Fl. 571. 1882.
= *Cimicifuga foetida* L. Syst., ed. 12, 659. 1767.
CINNAMOMUM CINNAMOMUM (L.) Karst. Deutsch. Fl. 503. 1881.
= *Cinnamomum zeylanicum* Blume, Bijd. Fl. Ned. Ind. 568. 1825.
CITRULLUS CITRULLUS (L.) Karst. Deutsch. Fl. 889. 1882.
= *Citrullus vulgaris* Schrad. in Eckl. & Zeyh. Enum. 279. 1836.
CLANDESTINA CLANDESTINA (L.) Huth, Helios **11**: 134. 1893.
= *Clandestina rectiflora* Lam. Fl. Fr. **2**: 328. 1778.
CLINOPODIUM CLINOPODIUM (Benth.) Degen in Magyar Bot. Lap. **4**: 131. 1905.
= *Clinopodium vulgare* L. Sp. Pl. 587. 1753.
COLOCASIA COLOCASIA (L.) Huth, Helios **11**: 134. 1893.
= *Colocasia antiquorum* Schott, Meletem. **1**: 18. 1832.
COLUBRINA COLUBRINA (Jacq.) Millsp., Field Columb. Mus. Bot. **2**: 69. 1900.
= *Colubrina ferruginosa* Brongn., Ann. Sc. Nat. Sér. 1, **10**: 369. 1827.
CONAMI CONAMI (Sw.) Britton, Sci. Surv. P. R. & Virgin Isls. **5**: 475. 1924.
= *Conami brasiliensis* Aubl. Pl. Guian. **2**: 927. 1775.
CORALLORRHIZA CORALLORRHIZA (L.) Karst. Deutsch. Fl. 448. 1881.[5]
= *Corallorrhiza trifida* Chatelain, Spec. Inaug. 8. 1760.
CORONARIA CORONARIA (L.) Huth, Helios **11**: 134. 1893.
= *Coronaria tomentosa* A. Br., Flora **26**: 368. 1843.
CORONOPUS CORONOPUS (L.) Karst. Deutsch. Fl. 673. 1882.
= *Coronopus Ruellii* All. Fl. Pedem. **1**: 256. 1785.
COTINUS COTINUS (L.) Sarg. Gard. & For. **4**: 340. 1891.
= *Cotinus coggygria* Scop. Fl. Carn., ed. 2, **1**: 220. 1772.
COTONEASTER COTONEASTER (L.) Karst. Deutsch. Fl. 785. 1882.
= *Cotoneaster integerrima* Medic. Gesch. 85. 1829.
CRUPINA CRUPINA (L.) Karst. Deutsch. Fl. 1126. 1883.
= *Crupina vulgaris* Pers. ex Cass., Dict. Sc. Nat. **12**: 68. 1818.
CUBEBA CUBEBA (L.) Karst. Deutsch. Fl. 478. 1881.
= *Cubeba officinalis* Raf. Sylv. Tellur. 84. 1838.
CURCAS CURCAS (L.) Britton & Millsp. Bahama Fl. 225. 1920.
= *Curcas indica* A. Rich. in Sagra, Hist. Cuba **11**: 208. 1850.

[4] This name is accredited by some authors to Cassini in "Dict. Sci. Nat. **8**: 78. 1817," but was never authentically published until by Greene in 1897.

[5] This combination is spelled *Coralliorrhiza Coralliorrhiza* by Aschers. & Graebn. in Fl. Nordostd. Flachl. 220. 1898.

CYANUS CYANUS (L.) Hill, Hort. Kew. 64. 1768.
= *Cyanus dentatofolius* Gilib. Fl. Lithuan. **1**: 191. 1781.
CYDONIA CYDONIA (L.) Karst. Deutsch. Fl. 783. 1882.
= *Cydonia oblonga* Mill. Gard. Dict., ed. 8, no. 1. 1768.
CYMBALARIA CYMBALARIA (L.) Wettst. in Engl. & Prantl, Nat. Pflanzenfam. **4**: Abt. 3b, 58. 1891.
= *Cymbalaria muralis* Gaertn. Meyer & Scherb. Fl. Wett. **2**: 397. 1800.
CYNOCRAMBE CYNOCRAMBE (L.) Huth, Helios **11**: 134. 1893.
= *Cynocrambe prostrata* Gaertn. Fruct. & Sem. **1**: 362, *pl. 75*. 1788.
DALEA DALEA (L.) MacM. Metasp. Minn. 330. 1892.
= *Dalea alopecuroides* Willd. Sp. Pl. **3**: 1336. 1800.
DAMASONIUM DAMASONIUM (L.) Druce, Brit. Pl. List, ed. 2, 116. 1928.
= *Damasonium stellatum* Thuill. Fl. Par., ed. 2, 186. 1799.
DIERVILLA DIERVILLA (L.) MacM., Bull. Torr. Bot. Club **19**: 15. 1892.[6]
= *Diervilla Lonicera* Mill. Gard. Dict., ed. 8. 1768.
DONAX DONAX (L.) Aschers. & Graebn. Fl. Nordostd. Flachl. 101. 1898.
= *Donax arundinaceus* Beauv. Es. Agrost. *pl. 16, f. 4*. 1812.
DRACUNCULUS DRACUNCULUS (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 1166. 1895.
= *Dracunculus vulgaris* Schott, Meletem. **1**: 17. 1832.
DRYOPTERIS DRYOPTERIS (L.) Britton in Britton & Br. Ill. Fl., ed. 2, **1**: 23. 1913.
= *Dryopteris Linneana* C. Ch. Ind. Fil. 275. 1905.
ECASTOPHYLLUM ECASTOPHYLLUM (L.) Huth, Helios **11**: 134. 1893.
= *Ecastophyllum Brownei* Pers. Syn. Pl. **2**: 277. 1807.
ECBOLIUM ECBOLIUM (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 812. 1895.
= *Ecbolium Linnaeanum* S. Kurz, Journ. As. Soc. Beng. **40**[2]: 75. 1871.
ECHITES ECHITES (L.) Britton ex Small, Fl. Miami 147, 200. 1913.
= *Echites umbellata* Jacq. Enum. Pl. Carib. 13. 1760.
ENTADA ENTADA (L.) Huth, Helios **11**: 134. 1893.
= *Entada monostachya* DC. Mém. Lég. 422, *pl. 61*. 1825.
EPIPOGON EPIPOGON (Crantz) Kern. Sched. Fl. Austro-Hung. **6**: 105. 1893.
= *Epipogon aphyllum* (Schm.) Sw. Summ. Veg. Scand. 32. 1814.
ERAGROSTIS ERAGROSTIS (L.) Beauv. Es. Agrost. Pl. 10. 1812.[7]
= *Egragrostis minor* Host, Fl. Austr. **1**: 135. 1827.
ERUCA ERUCA (L.) Aschers. & Graebn. Fl. Nordostd. Flachl. 362, 1898.
= *Eruca sativa* Mill. Gard. Dict., ed. 8, no. 1. 1768.
ERUCAGO ERUCAGO (L.) Huth, Helios **11**: 134. 1893.
= *Erucago dentata* Moench, Meth. 278. 1794.
ERUCASTRUM ERUCASTRUM (L.) Huth, Helios **11**: 134. 1893.
= *Erucastrum Pollichii* Schimp. & Spenn. in Spenn. Fl. Friburg. **3**: 946. 1829.
FAGARA FAGARA (L.) Small, Fl. SE. U. S. 674, 1333. 1903.
= *Fagara Pterota* L. Syst., ed. 10, 897. 1759.
FAGOPYRUM FAGOPYRUM (L.) Karst. Deutsch. Fl. 522. 1881.
= *Fagopyrum esculentum* Moench, Meth. 290. 1794.
FALCARIA FALCARIA (L.) Karst. Deutsch. Fl. 835. 1882.
= *Falcaria vulgaris* Bernh. Syst. Verz. Erf. 176. 1800.

[6] This combination is spelled *Diervillea Diervillea* by Voss in Vilmorin's Blumeng., ed. 3, **1**: 420. 1894.

[7] Vid. A. S. Hitchcock "*Eragrostis Eragrostis* (L.) Beauv." in Erythrea **2**: 37–39. 1894.

FICARIA FICARIA (L.) Karst. Deutsch. Fl. 565. 1882.
= *Ficaria verna* Huds. Fl. Angl. 214. 1762.

FILIPENDULA FILIPENDULA (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 240. 1894.
= *Filipendula hexapetala* Gilib. Fl. Lithuan. **2**: 237. 1781.

FOENICULUM FOENICULUM (L.) Karst. Deutsch. Fl. 837. 1882.
= *Foeniculum vulgare* Hill, Brit. Herb. 413. 1756.

FRANGULA FRANGULA (L.) Karst. Deutsch. Fl. 868. 1882.
= *Frangula Alnus* Mill. Gard. Dict., ed. 8, no. 1. 1768.

FUMANA FUMANA (L.) Karst. Deutsch. Fl. 633. 1882.
= *Fumana vulgaris* Spach, Ann. Sc. Nat. Sér. 2, **6**: 359. 1836.

GALACTITES GALACTITES (L.) Druce, Brit. Pl. List, ed. 2, 63. 1928.
= *Galactites tomentosa* Moench, Meth. 558. 1794.

GALEOBDOLON GALEOBDOLON (L.) Karst. Deutsch. Fl. 1010. 1883.
= *Galeobdolon luteum* Huds. Fl. Angl., ed. 2, **1**: 258. 1778.

GLAUCIUM GLAUCIUM (L.) Karst. Deutsch. Fl. 649. 1882.
= *Glaucium flavum* Crantz, Stirp. Austr. **2**: 131. 1763.

GUAZUMA GUAZUMA (L.) Cockerell, Bull. Torr. Bot. Club **19**: 95. 1892.
= *Guazuma ulmifolia* Lam. Encycl. **3**: 52. 1789.

HABENARIA HABENARIA (L.) Small, Fl. SE. U. S. 316, 1329. 1903.
= *Habenaria macroceratitis* (Sw.) Willd. Sp. Pl. **4**: 44. 1805.

HELENIUM HELENIUM (Nutt.) Small, Fl. SE. U. S. 1292, 1341. 1903.
= *Helenium leptopoda* Wood, Am. Bot. & Flor. 182. 1870.

HELIANTHEMUM HELIANTHEMUM (L.) Karst. Deutsch. Fl. 633. 1882.
= *Helianthemum Chamaecistus* Mill. Gard. Dict., ed. 8, no. 1. 1768.

HELLEBORINE HELLEBORINE (L.) Druce, Rep. Bot. Exch. Cl. Brit. Isles 1924, **7**: 689. 1925.
= *Helleborine latifolia* (All.) Druce, Dillen. Herb. 115. 1907.

HEPATICA HEPATICA (L.) Karst. Deutsch. Fl. 559. 1882.
= *Hepatica triloba* Chaix in Vill. Hist. Pl. Dauph. **1**: 336. 1786.

HYPOPITYS HYPOPITYS (L.) Small, Mem. Torr. Bot. Club **4**: 137. 1893.
= *Hypopitys multiflora* Scop. Fl. Carn., ed. 2, **1**: 285. 1760.

HYSTRIX HYSTRIX (L.) Millsp. Fl. W. Va. 474. 1892.
= *Hystrix patula* Moench, Meth. 295. 1794.

INGA INGA (L.) Britton, Fl. Bermuda 170. 1918.
= *Inga vera* Willd. Sp. Pl. **4**: 1010. 1806.

JAMBOS JAMBOS (L.) Lyons, Pl. Names 206. 1900.
= *Jambosa vulgaris* DC. Prodr. **3**: 286. 1828.

JUPUNBA JUPUNBA (Willd.) Britton & Rose, N. Am. Fl. **23**: 27. 1928.
= *Jupunba trapezifolia* (Vahl) Moldenke [see below].

KARATAS KARATAS (Jacq.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 963. 1895.
= *Karatas Plumieri* E. Morr. Belg. Hortic. 131. 1872.

LABLAB LABLAB (L.) Lyons, Pl. Names 212. 1900.
= *Lablab vulgaris* Savi, Diss. 19. 1821.

LABURNUM LABURNUM (L.) Dörfler, Herb. Norm. no. 3815. 1899.[8]
= *Laburnum anagyroides* Medic., Vorles. Churpf. Phys. Ges. **2**: 363. 1787.

[8] This combination appears to have been first used by Voss (as a synonym) in Vilmorin's Blumeng., ed. 3, **1**: 198. 1894.

LAGENARIA LAGENARIA (L.) Cockerell, Bull. Torr. Bot. Club **19**: 95. 1892.
= *Lagenaria vulgaris* Séringe, Mém. Soc. Phys. Genèv. **31**: 25. 1825.
LAPPA LAPPA (L.) Karst. Deutsch. Fl. 1121. 1883.
= *Lappa officinalis* All. Fl. Pedem. **1**: 145. 1785.
LAPPULA LAPPULA (L.) Karst. Deutsch. Fl. 979. 1882.
= *Lappula echinata* Gilib. Fl. Lithuan. **1**: 25. 1781.
LARIX LARIX (L.) Karst. Deutsch. Fl. 326. 1881.
= *Larix decidua* Mill. Gard. Dict., ed. 8, no. 1. 1768.
LENS LENS (L.) Huth, Helios **11**: 134. 1893.
= *Lens esculenta* Moench, Meth. 131. 1794.
LEONTOPODIUM LEONTOPODIUM (L.) Karst. Deutsch. Fl. 1074. 1883.
= *Leontopodium alpinum* Cass., Dict. Sc. Nat. **25**: 474. 1822.
LEPTOSTACHYS LEPTOSTACHYS (L.) MacM. Metasp. Minn. 442. 1892.
= *Leptostachys carolinensis* Kuntze, Rev. Gen. 508. 1891.
LEUCANTHEMUM LEUCANTHEMUM (L.) Rydb., N. Am. Fl. **34**: 235. 1916.
= *Leucanthemum vulgare* Lam. Fl. Fr. **2**: 137. 1778.
LEVISTICUM LEVISTICUM (L.) Karst. Deutsch. Fl. 844. 1882.
= *Levisticum officinale* Koch, Nov. Act. Nat. Cur. **12**[1]: 101, *f. 41*. 1824.
LIBANOTIS LIBANOTIS (L.) Karst. Deutsch. Fl. 842. 1882.
= *Libanotis montana* Crantz, Stirp. Austr., ed. 1, 3: 117. 1767.
LIMONIUM LIMONIUM (L.) Lyons, Pl. Names 225. 1900.
= *Limonium vulgare* Mill. Gard. Dict., ed. 8, no. 1. 1768.
LINARIA LINARIA (L.) Karst. Deutsch. Fl. 947. 1882.
= *Linaria vulgaris* Hill, Brit. Herb. 108. 1756.
LINOSYRIS LINOSYRIS (L.) Karst. Deutsch. Fl. 1066. 1883.
= *Linosyris vulgaris* Cass. ex Less. Syn. Comp. 195. 1832.
LITCHI LITCHI (Lour.) Britton, Fl. Bermuda 226. 1918.
= *Litchi chinensis* Sonner. Voy. Ind. **2**: 230. 1782.
LUFFA LUFFA (L.) Lyons, Pl. Names 231. 1900.
= *Luffa aegyptiaca* Mill. Gard. Dict., ed. 8. 1768.
LYCOPERSICUM LYCOPERSICUM (L.) Karst. Deutsch. Fl. 966. 1882.[9]
= *Lycopersicum esculentum* Mill. Gard. Dict., ed. 8. 1768.
MAJORANA MAJORANA (L.) Karst. Deutsch. Fl. 999. 1882.
= *Majorana hortensis* Moench, Meth. 406. 1794.
MALUS MALUS (L.) Britton in Britton & Br. Ill. Fl., ed. 2, **2**: 290. 1913.[10]
= *Malus sylvestris* Mill. Gard. Dict., ed. 8, no. 1. 1768.
MALVAVISCUS MALVAVISCUS (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 142. 1894.
= *Malvaviscus arboreus* Cav. Diss. **3**: 131, *pl. 48, f. 1*. 1790.
MANIHOT MANIHOT (L.) Karst. Deutsch. Fl. 588. 1882.
= *Manihot utilissima* Pohl, Fl. Bras. Ic. **1**: 32, *pl. 24*. 1827.
MARIANA MARIANA (L.) Hill, Hort. Kew. 61. 1768.
= *Mariana lactea* Hill, Herb. Brit. **1**: 75. 1769.
MARISCUS MARISCUS (L.) Borbás, Balaton Fl. 321. 1900.
= *Mariscus serratus* Gilib. Exerc. Phyt. **2**: 512. 1792.

[9] This combination is spelled *Lycopersicon Lycopersicon* by Britton in Britton & Br. Ill. Fl., ed. 2, **3**: 168. 1913.

[10] This combination appears to have been first used by Voss (as a synonym) in Vilmorin's Blumeng., ed. 3, **1**: 275. 1894.

MELOCACTUS MELOCACTUS (L.) Karst. Deutsch. Fl. 888. 1882.
= *Melocactus communis* Link & Otto, Verh. Preuss. Ver. Gartenb. **3**: 417, *pl. 11.* 1827.

METHYSTICUM METHYSTICUM (Forst.) Lyons, Pl. Names 247. 1900.
= *Methysticum esculentum* Raf. Sylv. Tellur. 85. 1838.

METOPIUM METOPIUM (L.) Small, Fl. SE. U. S. 726, 1334. 1903.
= *Metopium Linnaei* Engl. in DC. Monog. Phan. **4**: 367. 1883.

MEUM MEUM (L.) Karst. Deutsch. Fl. 839. 1882.
= *Meum athamanticum* Jacq. Fl. Austr. **4**: 2. 1776.

MOLDAVICA MOLDAVICA (L.) Britton in Britton & Br. Ill. Fl., ed. 2, **3**: 115. 1913.
= *Moldavica suaveolens* Gilib. Fl. Lithuan. **1**: 79. 1781.

MONNIERA MONNIERA (L.) Britton, Mem. Torr. Bot. Club **5**: 292. 1894.
= *Monniera Brownei* Pers. Syn. Pl. **2**: 166. 1806.

MORINGA MORINGA (L.) Millsp., Field Mus. Bot. **1**: 490. 1902.
= *Moringa oleifera* Lam. Encycl. **1**: 398. 1783.

MUSCARI MUSCARI (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 124. 1894.
= *Muscari moschatum* Willd. Enum. Hort. Berol. 378. 1809.

NASTURTIUM NASTURTIUM (L.) Cockerell, Bull. Torr. Bot. Club **19**: 95. 1892.
= *Nasturtium officinale* R. Br. in Ait. Hort. Kew., ed. 2, **4**: 111. 1812.

NEGUNDO NEGUNDO (L.) Karst. Deutsch. Fl. 596. 1882.
= *Negundo aceroides* Moench, Meth. 334. 1794.

NELUMBO NELUMBO (L.) Karst. Deutsch. Fl. 553. 1882.
= *Nelumbo nucifera* Gaertn. Fruct. & Sem. **1**: 73, *pl. 19.* 1788.

NUMMULARIA NUMMULARIA (Bull.) Karst. Deutsch. Fl. 138. 1881.
= *Nummularia Bulliardi* Tul. Sel. Fungor. Carp. **2**: 43, *pl. 5, f. 11–19.* 1863.

NYCTELEA NYCTELEA (L.) Britton in Britton & Br. Ill. Fl., ed. 2, **3**: 67. 1913.
= *Nyctelea americana* Moldenke [see below].

NYMPHOIDES NYMPHOIDES (L.) Druce, Brit. Pl. List, ed. 2, 79. 1928.
= *Nymphoides orbiculata* Gilib. Fl. Lithuan. **1**: 33. 1781.

ODONTITES ODONTITES (L.) Wettst. in Engl. & Prantl, Nat. Pflanzenfam. **4**: Abt. 3b, 102. 1891.
= *Odontites rubra* Gilib. Fl. Lithuan. **1**: 126. 1781.

OMPHALODES OMPHALODES (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 693. 1895.
= *Omphalodes verna* Moench, Meth. 420. 1794.

ONOBRYCHIS ONOBRYCHIS (L.) Karst. Deutsch. Fl. 681. 1882.
= *Onobrychis viciaefolia* Scop. Fl. Carn., ed. 2, **2**: 76. 1772.

OPOPANAX OPOPANAX (L.) Karst. Deutsch. Fl. 847. 1882.
= *Opopanax Chironium* Koch, Nov. Act. Nat. Cur. **12**[1]: 96. 1825.

OPUNTIA OPUNTIA (L.) Karst. Deutsch. Fl. 888. 1882.
= *Opuntia compressa* (Salisb.) Macbr., Contrib. Gray Herb. **65**: 41. 1922.

ORNUS ORNUS (L.) Karst. Deutsch. Fl. 1045. 1883.
= *Ornus europaea* Pers. Syn. Pl. **1**: 8. 1805.

OSTRYA OSTRYA (L.) MacM. Metasp. Minn. 187. 1892.
= *Ostrya virginiana* (Mill.) Willd. Sp. Pl. **4**: 469. 1805.

OSTRYA OSTRYA (L.) Sarg. Silv. N. Am. **9**: 32. 1896.
= *Ostrya carpinifolia* Scop. Fl. Carn., ed. 2, **2**: 244. 1772.

OTOBA OTOBA (Humb. & Bonpl.) Karst. Deutsch. Fl. 578. 1882.
= *Otoba novogranatensis* Moldenke [see below].

OXYCOCCUS OXYCOCCUS (L.) MacM., Bull. Torr. Bot. Club **19**: 15. 1892.
= *Oxycoccus palustris* Pers. Syn. Pl. **1**: 419. 1805.
PALIURUS PALIURUS (L.) Karst. Deutsch. Fl. 870. 1882.
= *Paliurus australis* Gaertn. Fruct. & Sem. **1**: 203, *pl. 43*. 1788.
PAPAYA PAPAYA (L.) Karst. Deutsch. Fl. 894. 1882.
= *Papaya communis* Noronha, Verh. Batav. Gen. 5, ed. 1, art. 4, 23. 1790.
PARSONSIA PARSONSIA (L.) Britton ex Northrop, Mem. Torr. Bot. Club **12**: 53. 1902.
= *Parsonsia herbacea* J. St. Hil. Exp. Fam. Nat. **2**: 173. 1805.
PAVIA PAVIA (L.) Huth, Helios **11**: 135. 1893.
= *Pavia octandra* Mill. Gard. Dict., ed. 8, no. 1. 1768.
PENTSTEMON PENTSTEMON (L.) Britton, Mem. Torr. Bot. Club **5**: 291. 1894.[11]
= *Pentstemon laevigatus* Soland. in Ait. Hort. Kew. **2**: 300. 1789.
PENTSTEMON PENTSTEMON (L.) MacM., Bull. Torr. Bot. Club **19**: 15. 1892.
= *Pentstemon hirsutus* (L.) Willd. Sp. Pl. **3**: 227. 1801.
PERESKIA PERESKIA (L.) Karst. Deutsch. Fl. 888. 1882.[12]
= *Pereskia aculeata* Mill. Gard. Dict., ed. 8. 1768.
PERSEA PERSEA (L.) Cockerell, Bull. Torr. Bot. Club **19**: 95. 1892.
= *Persea gratissima* Gaertn. f. Fruct. & Sem. **3**: 222. 1807.
PERSICARIA PERSICARIA (L.) Small, Fl. SE. U. S. 378, 1330. 1903.
= *Persicaria mitis* Gilib. Exerc. Phyt. 431. 1792.
PETASITES PETASITES (L.) Karst. Deutsch. Fl. 1062. 1883.
= *Petasites officinalis* Moench, Meth. 568. 1794.
PETROSELINUM PETROSELINUM (L.) Karst. Deutsch. Fl. 831. 1882.
= *Petroselinum sativum* Hoffm. Gen. Umb. 177. 1814.
PHEGOPTERIS PHEGOPTERIS (L.) Keyserling, Polyp. & Cyath. Herb. Bung. 50. 1873.
= *Phegopteris polypodioides* Fée, Gen. Fil. 243. 1852.
PHRAGMITES PHRAGMITES (L.) Karst. Deutsch. Fl. 379. 1881.
= *Phragmites communis* Trin. Fund. Agrost. 134. 1820.
PHYMATODES PHYMATODES (L.) Maxon, Contrib. U. S. Nat. Herb. **9**: 352. 1905.
= *Phymatodes vulgaris* Presl, Tent. 196. 1836.
PHYSALODES PHYSALODES (L.) Britton, Mem. Torr. Bot. Club **5**: 287. 1892.[13]
= *Physalodes peruvianum* Kuntze, Rev. Gen. 452. 1891.
PIMENTA PIMENTA (L.) Karst. Deutsch. Fl. 790. 1882.
= *Pimenta officinalis* Lindl. Coll. Bot. sub *pl. 19*. 1821.
POLYGONATUM POLYGONATUM (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 1069. 1895.[14]
= *Polygonatum officinale* All. Fl. Pedem. **1**: 131. 1785.
POLYPORUS POLYPORUS (Retz) Murrill, Bull. Torr. Bot. Club **31**: 33. 1904.
= *Polyporus brumalis* (Pers.) Fries, Obs. Myc. **2**: 255. 1818.
POROPHYLLUM POROPHYLLUM (L.) Kuntze, Rev. Gen. Pl. **3**[2]: 168. 1898.
= *Porophyllum ellipticum* Cass., Dict. Sc. Nat. **43**: 56. 1826.

[11] This combination is spelled *Pentastemon Pentastemon* by Voss in Vilmorin's Blumeng., ed. 3, **1**: 768. 1895.

[12] This combination is spelled *Piereskia Piereskia* by Voss in Vilmorin's Blumeng., ed. 3, **1**: 385. 1894.

[13] This combination is erroneously spelled *Physaloides Physaloides* by Durand & Jackson in Ind. Kew. Suppl. **1**: 328. 1903.

[14] This combination appears (as a synonym) accredited to Jirasek in Roemer & Schultes Syst. Veg. **7**: 299. 1829.

PULEGIUM PULEGIUM (L.) Karst. Deutsch. Fl. 997. 1882.
= *Pulegium vulgare* Mill. Gard. Dict., ed. 8, no. 1. 1768.

PULICARIA PULICARIA (L.) Karst. Deutsch. Fl. 1072. 1883.
= *Pulicaria vulgaris* Gaertn. Fruct. & Sem. **2**: 461, *pl. 173*. 1791.

PULSATILLA PULSATILLA (L.) Karst. Deutsch. Fl. 560. 1882.
= *Pulsatilla vulgaris* Mill. Gard. Dict., ed. 8, no. 1. 1768.

PYRACANTHA PYRACANTHA (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 269. 1894.
= *Pyracantha coccinea* M. Roem. Syn. fasc. 3, Rosifl., 219. 1847.

QUAMOCLIT QUAMOCLIT (L.) Britton in Britton & Br. Ill. Fl., ed. 1, **3**: 22. 1898.
= *Quamoclit vulgaris* Choisy in DC. Prodr. **9**: 336. 1845.

RADIOLA RADIOLA (L.) Karst. Deutsch. Fl. 606. 1882.
= *Radiola linoides* Roth, Tent. Fl. Germ. **1**: 71. 1788.

RAPHANISTRUM RAPHANISTRUM (L.) Karst. Deutsch. Fl. 673. 1882.
= *Raphanistrum Lampsana* Gaertn. Fruct. & Sem. **2**: 300, *pl. 143*. 1791.

RHAPONTICUM RHAPONTICUM (L.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 554. 1894.
= *Rhaponticum scariosum* Lam. Fl. Fr. **2**: 38. 1778.

RICINELLA RICINELLA (L.) Britton ex P. Wilson, Bull. N. Y. Bot. Gard. **8**: 395. 1917.
= *Ricinella pedunculosa* Muell. Arg., Linnaea **34**: 153. 1865.

ROCELLA ROCELLA (L.) Karst. Deutsch. Fl. 164. 1881.
= *Rocella tinctoria* DC. Fl. Fr. **2**: 334. 1805.

SANGUISORBA SANGUISORBA (L.) Britton, Mem. Torr. Bot. Club **5**: 189. 1894.
= *Sanguisorba minor* Scop. Fl. Carn., ed. 2, **1**: 110. 1772.

SASSAFRAS SASSAFRAS (L.) Karst. Deutsch. Fl. 505. 1881.
= *Sassafras variifolium* (Salisb.) Kuntze, Rev. Gen. Pl. 574. 1891.

SCOLOPENDRIUM SCOLOPENDRIUM (L.) Karst. Deutsch. Fl. 278. 1881.
= *Scolopendrium vulgare* Symons, Mém. Ac. Turin **5**: 421, *pl. 9, f. 2*. 1793.

SCOPOLIA SCOPOLIA (L.) Karst. Deutsch. Fl. 962. 1882.
= *Scopolia carniolica* Jacq. Obs. Bot. **1**: 32, *pl. 20*. 1764.

SCORODONIA SCORODONIA (L.) Karst. Deutsch. Fl. 1016. 1883.
= *Scorodonia heteromalla* Moench, Meth. 384. 1794.

SELLIGUEA SELLIGUEA (Mett.) Christ, Bull. Boiss. 6^2: 992. 1906.
= *Selliguea membranacea* Blume, Enum. Pl. addend. 1828.

SESBAN SESBAN (L.) Britton, Mem. Brooklyn Bot. Gard. **1**: 54. 1918.
= *Sesbania aegyptica* Pers. Syn. Pl. **2**: 316. 1807.

SILAUS SILAUS (L.) Karst. Deutsch. Fl. 836. 1882.
= *Silaus flavescens* Bernh. Syst. Verz. Erf. 174. 1800.

SOJA SOJA (L.) Karst. Deutsch. Fl. 711. 1882.
= *Soja Max* (L.) Piper, U. S. Dept. Agr. Bur. Pl. Ind. Invent. Seeds & Pl. Import. 33: 53. 1915.

SOPHIA SOPHIA (L.) Britton in Britton & Br. Ill. Fl., ed. 1, **2**: 144. 1897.
= *Sophia multifida* Gilib. Exerc. Phyt. **1**: 243. 1792.

SORGHUM SORGHUM (L.) Karst. Deutsch. Fl. 367. 1881.
= *Sorghum vulgare* Pers. Syn. Pl. **1**: 101. 1805.

STROBUS STROBUS (L.) Small, Fl. SE. U. S. 29, 1326. 1903.
= *Strobus Weymouthiana* Opiz, Lotos **4**: 94. 1854.

SUCCISA SUCCISA (L.) Karst. Deutsch. Fl. 1053. 1883.
= *Succisa pratensis* Moench, Meth. 489. 1794.

SYMPHORICARPOS SYMPHORICARPOS (L.) MacM., Bull. Torr. Bot. Club **19**: 15. 1892.[15]
= *Symphoricarpos orbiculatus* Moench, Meth. 503. 1794.

TARAXACUM TARAXACUM (L.) Karst. Deutsch. Fl. 1138. 1883.
= *Taraxacum officinale* Weber, Prim. Pl. Holst. 56. 1780.

THELYPTERIS THELYPTERIS (L.) Nieuwland, Midland Nat. **1**: 226. 1910.
= *Thelypteris palustris* Schott, Gen. *pl. 10*. 1834.

THEVETIA THEVETIA (L.) Karst. Deutsch. Fl. 1035. 1883.
= *Thevetia nereifolia* Juss. ex Steud. Nom. Bot., ed. 2, **2**: 680. 1841.

TOXICODENDRON TOXICODENDRON (L.) Britton in Britton & Br. Ill. Fl., ed. 2, **2**: 484. 1913.
= *Toxicodendron pubescens* Mill. Gard. Dict., ed. 8, no. 2. 1768.

TUBER TUBER (L.) Karst. Deutsch. Fl. 131. 1881.
= *Tuber cibarium* Sibth. Flor. Oxon. 398. 1794.

UGNI UGNI (Mol.) Voss, Vilmorin's Blumeng., ed. 3, **1**: 315. 1894.
= *Ugni Molinae* (Barn.) Turcz., Bull. Soc. Nat. Mosc. **21**[1]: 579. 1848.

ULMARIA ULMARIA (L.) Barnh., Bull. Torr. Bot. Club **21**: 491. 1894.
= *Ulmaria palustris* Moench, Meth. 663. 1794.

UVA-URSI UVA-URSI (L.) Cockerell ex Daniels, Univ. Missouri Studies Sc. Ser. 2, no. 2, 186. 1911.
= *Uva-ursi procumbens* Moench, Meth. 470. 1794.

VACCARIA VACCARIA (L.) Britton in Britton & Br. Ill. Fl., ed. 1, **2**: 18. 1897.
= *Vaccaria vulgaris* Host, Fl. Austr. **1**: 518. 1827.

VANILLA VANILLA (L.) Karst. Deutsch. Fl., ed. 2, **1**: 474. 1895.
= *Vanilla planifolia* Andr. Bot. Rep. **8**: *pl. 538*. 1808.

VINCETOXICUM VINCETOXICUM (L.) Karst. Deutsch. Fl. 1030. 1883.
= *Vincetoxicum officinale* Moench, Meth. 717. 1794.

VIORNA VIORNA (L.) Small, Fl. SE. U. S. 439, 1331. 1903.
= *Viorna urnigera* Spach, Hist. Veg. Phan. **7**: 270. 1839.

VISCARIA VISCARIA (L.) Voss ex Aschers. & Graebn. Fl. Nordostd. Flachl. 299. 1898.[16]
= *Viscaria vulgaris* Roehl. Deutsch. Fl., ed. 2, **2**: 275. 1812.

VITICELLA VITICELLA (L.) Small, Fl. SE. U. S. 437, 1330. 1903.
= *Viticella deltoidea* Moench, Meth. 297. 1794.

VITIS-IDAEA VITIS-IDAEA (L.) Britton, Bull. N. Y. Bot. Gard. **3**: 179. 1903.
= *Vitis-Idaea punctata* Moench, Meth. 47. 1794.

ZINGIBER ZINGIBER (L.) Karst. Deutsch. Fl. 471. 1881.
= *Zingiber officinale* Roscoe, Trans. Linn. Soc. **8**: 348. 1807.

ZIZYPHUS ZIZYPHUS (L.) Karst. Deutsch. Fl. 870. 1882.
= *Zizyphus sativa* Gaertn. Fruct. & Sem. **1**: 202. 1788.

In this connection it is interesting to note the number of important synonyms which are omitted from the majority of our popular manuals and handbooks—even in many cases from works which as a rule give

[15] This combination is spelled *Symphoricarpus Symphoricarpus* by Huth in Helios **11**: 136. 1893.

[16] This combination appears to have been first used (as a synonym) by Voss in Vilmorin's Blumeng., ed. 3, **1**: 100. 1894.

rather complete lists of synonymy for other species. Many of these synonyms are important because of their relation to the shifting of species from one genus to another and to the process of splitting up of old genera into smaller ones which seems to be the practice in so many quarters of the botanical world today. Many of the larger and more generally accepted genera are being divided into smaller segregates by present day monographers, and many others have been so divided in the past. It happens, however, that many of the names thus produced have been overlooked in popular lists of synonymy and one is frequently confronted with problems such as the following: Britton & Brown's Illustrated Flora maintains the genus *Padus* as distinct from the genus *Prunus*, while Gray's New Manual of Botany does not. Now, if the fifteen or more species of racemose cherries are to be kept distinct, as the genus *Padus*, from the ninety-five or more umbellate and corymbose species (the genus *Prunus* proper), then it is obvious that the *Prunus Padus* of Linnaeus, mentioned in Gray's School and Field Book of Botany, belongs to the genus *Padus* and not *Prunus*. And yet a botanist unable to avail himself of the research facilities of a large botanical library finds himself unable to label any specimens of *Prunus Padus* which he may happen to collect because nowhere in any popular work on American wild or cultivated plants, is there any synonym given for *Prunus Padus* within the genus *Padus*. He cannot use the combination *Padus Padus* because of the international rules of nomenclature which explicitly forbid such a repetition. He must, therefore, either accept the name *Padus* for all other species of racemose cherries except that one and still continue to call the European Bird Cherry a "Prunus," or else not adopt the name *Padus* at all and continue to call all cherries, both the racemose and the corymbose, by the name "Prunus."

In the following list a few of the more interesting of these cases are presented. In some instances (as, for example, in the case of *Amygdalus*, *Padus*, *Sorbus*, *Grossularia*, *Melilotus*, etc.) the segregated genera are today accepted as valid genera by numerous taxonomists of recognized standing. The opportunity presented in these instances for the manufacture of new tautonyms has so far, fortunately, been overlooked. The labors of the tautonym-makers, thus, while extensive, have by no means exhausted the opportunities for making such combinations. It is to be sincerely hoped, however, in view of the continued disfavor with which such bizarre combinations are regarded by the great majority of botanists throughout the world and at all international botanical congresses, that no more such "double binomials" will appear in the future and necessitate any supplement to the list given on the preceding pages.

ACORUS CALAMUS L. Sp. Pl. 324. 1753.
Calamus aromaticus Gueldenst. in Ledeb. Fl. Ross. **4**: 13. 1853.
AESCULUS HIPPOCASTANUM L. Sp. Pl. 344. 1753.
Hippocastanum vulgare Gaertn. Fruct. & Sem. **2**: 135, *pl. 3*. 1791.
ALLIUM CEPA L. Sp. Pl. 300. 1753.
Cepa prolifera Moench, Meth. 244. 1794.
ARBUTUS UNEDO L. Sp. Pl. 395. 1753.
Unedo edulis Hoffmgg. & Link, Fl. Port. **1**: 415. 1809.
ARTEMISIA ABSINTHIUM L. Sp. Pl. 848. 1753.
Absinthium vulgare Lam. Fl. Fr. **2**: 45. 1778.
CROTON TIGLIUM L. Sp. Pl. 1004. 1753.
Tiglium officinale Klotzsch, Nov. Act. Nat. Cur. 19, suppl. 1, 418. 1843.
CUCURBITA PEPO L. Sp. Pl. 1010. 1753.
Pepo vulgaris Moench, Meth. 653. 1794.
CYPERUS PAPYRUS L. Sp. Pl. 47. 1753.
Papyrus antiquorum Willd., Abh. Acad. Berl. 70. 1812.
DATURA STRAMONIUM L. Sp. Pl. 179. 1753.
Stramonium foetidum Scop. Fl. Carn., ed. 2, **1**: 157. 1772.
DAUCUS CAROTA L. Sp. Pl. 242. 1753.
Carota sativa Rupr. Fl. Ingric. 468. 1860.
GARCINIA MANGOSTANA L. Sp. Pl. 443. 1753.
Mangostana Garcinia Gaertn. Fruct. & Sem. **2**: 105. 1791.
HIPPOMANE MANCINELLA L. Sp. Pl. 1191. 1753.
Mancinella venenata Tussac, Fl. Antill. **3**: 21, *pl. 5*. 1824.
HUMULUS LUPULUS L. Sp. Pl. 1028. 1753.
Lupulus Humulus Mill. Gard. Dict., ed. 8. 1768.
ILEX AQUIFOLIUM L. Sp. Pl. 125. 1753.
Aquifolium Ilex Scop. Fl. Carn., ed. 2, **1**: 116. 1772.
IMPERATORIA OSTRUTHIUM L. Sp. Pl. 259. 1753.
Ostruthium officinale Link, Handb. **1**: 360. 1829.
JUNIPERUS SABINA L. Sp. Pl. 1039. 1753.
Sabina officinalis Garcke, Fl. Deutschl., ed. 4, 387. 1849.
LEONURUS CARDIACA L. Sp. Pl. 584. 1753.
Cardiaca vulgaris Moench, Meth. 401. 1794.
LONICERA CAPRIFOLIUM L. Sp. Pl. 173. 1753.
Caprifolium hortense Lam. Fl. Fr. **3**: 365. 1792.
LONICERA PERICLYMENUM L. Sp. Pl. 173. 1753.
Periclymenum vulgare Mill. Gard. Dict., ed. 8, no. 6. 1768.
LONICERA XYLOSTEUM L. Sp. Pl. 174. 1753.
Xylosteon dumetorum Moench, Meth. 502. 1794.
LYSIMACHIA NUMMULARIA L. Sp. Pl. 148. 1753.
Nummularia repens Gilib. Fl. Lithuan. **1**: 29. 1781.
LYTHRUM SALICARIA L. Sp. Pl. 446. 1753.
Salicaria vulgaris Moench, Meth. 665. 1794.
MATTEUCCIA STRUTHEOPTERIS (L.) Todaro, Syn. Pl. Acot. Vasc. Silicia 30. 1866.
Strutheopteris filicastrum All. Fl. Pedem. **2**: 283. 1785.
MELIA AZADIRACHTA L. Sp. Pl. 385. 1753.
Azadirachta indica A. Juss., Mém. Mus. Par. **19**: 220. 1830.

MELIA AZEDARACH L. Sp. Pl. 384. 1753.
Azedarach Commelini Medic. Bot. Beobacht. 164. 1782.
MIRABILIS JALAPA L. Sp. Pl. 177. 1753.
Jalapa officinalis Crantz, Inst. **2**: 266. 1766.
NARCISSUS JONQUILLA L. Sp. Pl. 290. 1753.
Jonquilla major Haw. Monog. Narciss. 7. 1831.
NEPETA CATARIA L. Sp. Pl. 570. 1753.
Cataria tomentosa Gilib. Fl. Lithuan. **1**: 78. 1781.
NEPETA GLECHOMA Benth. Lab. Gen. & Sp. 485. 1834.
Glecoma hederacea L. Sp. Pl. 578. 1753.
NERIUM OLEANDER L. Sp. Pl. 209. 1753.
Oleander vulgaris Medic., Act. Acad. Theod. Palat. 6, phys. 381. 1790.
NICOTIANA TABACUM L. Sp. Pl. 180. 1753.
Tabacum ovatofolium Gilib. Fl. Lithuan. **1**: 39. 1781.
OENANTHE PHELLANDRIUM Lam. Fl. Fr. **3**: 432. 1778.
Phellandrium aquaticum L. Sp. Pl. 255. 1753.
PHACELIA WHITLAVIA A. Gray, Proc. Am. Acad. **10**: 321. 1875.
Whitlavia grandiflora Harv. in Hook. Lond. Journ. Bot. **5**: 312. 1846.
PHYLLANTHUS EMBLICA L. Sp. Pl. 982. 1753.
Emblica officinalis Gaertn. Fruct. & Sem. **2**: 122, *pl. 108, f. 2*. 1791.
PHYSALIS ALKEKENGI L. Sp. Pl. 183. 1753.
Alkekengi officinarum Moench, Meth. Suppl. 177. 1802.
PIMPINELLA ANISUM L. Sp. Pl. 264. 1753.
Anisum vulgare Gaertn. Fruct. & Sem. **1**: 23. 1788.
POTENTILLA TORMENTILLA Neck., Act. Acad. Theod. Palat. **2**: 491. 1770.
Tormentilla erecta L. Sp. Pl. 500. 1753.
PRUNUS AMYGDALUS Stokes, Bot. Mat. Med. **3**: 101. 1812.
Amygdalus communis L. Sp. Pl. 473. 1753.
PRUNUS CERASUS L. Sp. Pl. 474. 1753.
Cerasus vulgaris Mill. Gard. Dict., ed. 8, no. 1. 1768.
PRUNUS PADUS L. Sp. Pl. 473. 1753.
Padus Avium Mill. Gard. Dict., ed. 8, no. 1. 1768.[17]
PSIDIUM GUAJAVA L. Sp. Pl. 470. 1753.
Guajava pyriformis Gaertn. Fruct. & Sem. **1**: 185, *pl. 38*. 1788.
PUNICA GRANATUM L. Sp. Pl. 472. 1753.
Granatum punicum St. Lag., Ann. Soc. Bot. Lyon, **7**: 132. 1880.
PYRUS SORBUS Gaertn. Fruct. & Sem. **2**: 45, *pl. 87*. 1791.
Sorbus domestica L. Sp. Pl. 477. 1753.
RHAMNUS ALATERNUS L. Sp. Pl. 193. 1753.
Alaternus Phylica Mill. Gard. Dict., ed. 8, no. 1. 1768.
RIBES GROSSULARIA L. Sp. Pl. 201. 1753.
Grossularia reclinata (L.) Mill. Gard. Dict., ed. 8, no. 4. 1768.
ROBINIA PSEUDACACIA L. Sp. Pl. 722. 1753.
Pseudo-Acacia vulgaris Medic., Vorles. Churpf. Phys. Ges. **2**: 364. 1787.

[17] This is not to be confused with the *Prunus Avium* of Linnaeus (Fl. Suec., ed. 2, 474. 1755), which is the common Sweet Cherry and a true member of the genus *Prunus* proper.

RUMEX ACETOSA L. Sp. Pl. 337. 1753.
Acetosa magna Gilib. Exerc. Phyt. **2**: 445. 1792.
RUMEX ACETOSELLA L. Sp. Pl. 338. 1753.
Acetosella vulgaris Fourr., Ann. Soc. Linn. Lyon, N. S. **17**: 145. 1869.
SALSOLA KALI L. Sp. Pl. 222. 1753.
Kali Soda Moench, Meth. 331. 1794.
SELINUM CREOSELINUM Crantz, Stirp. Austr., ed. 1, 3: 33. 1767.
Creoselinum legitimum Bieb. Fl. Taur. Cauc. **3**: 211. 1819.
SEMECARPUS ANACARDIUM L. f. Suppl. 182. 1781.
Anacardium officinarum Gaertn. Fruct. & Sem. **1**: 92. 1788.
SENECIO CINERARIA DC. Prodr. **6**: 355. 1837.
Cineraria maritima L. Sp. Pl., ed. 2, 1244. 1763.
SEQUOIA WELLINGTONIA Seem., Bonplandia **3**: 27. 1855.
Wellingtonia gigantea Lindl. Gard. Chron. 819, 823. 1853.
SOLANUM DULCAMARA L. Sp. Pl. 185. 1753.
Dulcamara flexuosa Moench, Meth. 514. 1794.
THEOBROMA CACAO L. Sp. Pl. 782. 1753.
Cacao sativa Aubl. Pl. Guian. **2**: 689. 1775.
TRIFOLIUM MELILOTUS L. Sp. Pl. 764. 1753.
Melilotus indica (L.) All. Fl. Pedem. **1**: 308. 1785.
TRIGONELLA FOENUM-GRAECUM L. Sp. Pl. 777. 1753.
Foenum-Graecum sativum Medic., Vorles. Churpf. Phys. Ges. **2**: 383. 1787.
VALERIANA LOCUSTA L. Sp. Pl. 33. 1753.
Locusta communis Delarb. Fl. Auv., ed. 2, 88. 1800.
VERBASCUM BLATTARIA L. Sp. Pl. 178. 1753.
Blattaria vulgaris Fourr., Ann. Soc. Linn. Lyon, N. S. **17**: 125. 1869.
VERBASCUM LYCHNITIS L. Sp. Pl. 177. 1753.
Lychnitis alba Fourr., Ann. Soc. Linn. Lyon, N. S. **17**: 125. 1869.
VERBASCUM THAPSUS L. Sp. Pl. 177. 1753.
Thapsus Schraderi Opiz, Seznam 96. 1852.

Jupunba trapezifolia (Vahl) Moldenke, comb. nov.

Since the generic name *Jupunba* proposed by Britton & Rose (N. Am. Fl. **23**: 24. 1928) is considered distinct from *Pithecellobium*, *Acacia*, *Inga*, and *Mimosa*, the *Acacia Jupunba* of Willdenow (Sp. Pl. **4**: 1067. 1806) must receive a new specific name. The combination *Jupunba Jupunba* proposed by Britton & Rose (N. Am. Fl. **23**: 27. 1928) is untenable because of being a tautonym. The next earliest name applied to this species, we find, is the *Mimosa trapezifolia* of Vahl (Eclog. **3**: 36. 1807). The combination *Jupunba trapezifolia* is therefore hereby proposed for this plant.

Nyctelea americana Moldenke, nom. nov.

The generic name *Nyctelea* of Scopoli (Introd. 183. 1777) was resurrected by Britton in 1913 and maintained in preference to the *Macrocalyx* of Trew (Nov. Act. Nat. Cur. **2**: 330–332. 1761) and the *Ellisia* of Lin-

naeus (Sp. Pl., ed. 2, 1662. 1763) because of the following considerations: (1) the generic name *Macrocalyx* being a mere hyponym and (2) the generic name *Ellisia* as published by Linnaeus in the second edition of his Species Plantarum (1763) being a homonym of the genus of the same name published by him in the tenth edition of his Systema Naturae (p. 1121. 1759). Since the genus *Nyctelea*, then, is to be maintained it appears that the *Ellisia Nyctelea* of Linnaeus (Sp. Pl., ed. 2, 1662. 1763) must take on a new specific name. The combination *Nyctelea Nyctelea* proposed by Britton (Britton & Br. Ill. Fl., ed. 2, **3:** 67. 1913) is untenable because of Article 55 of the Vienna Rules, the principle of which was confirmed at Cambridge in 1930. Inasmuch as no other specific name besides that of Linnaeus appears ever to have been applied to this plant, the name *Nyctelea americana* is hereby proposed. Since 1913, then, four species have been placed in the genus *Nyctelea*. These are as follows: (1) *Nyctelea micrantha* (Torr.) Woot. & Standl. [Contrib. U. S. Nat. Herb. **19:** 535. 1915]; (2) *Nyctelea ambigua* (Nutt.) Standl. [Proc. Biol. Soc. Wash. **32:** 143. 1919]; (3) *Nyctelea pinetorum* (Jones) Tidestrom [Contrib. U. S. Nat. Herb. **25:** 442. 1925]; and (4) *Nyctelea americana* Moldenke (*Ellisia Nyctelea* L.).

Otoba novogranatensis Moldenke, nom. nov.

Karsten in his Deutsche Flora (p. 578. 1882) appears to have been the first to make use of the generic name *Otoba* which he there accredits to Alphonse de Candolle. According to Karsten the genus *Otoba* is distinguished from *Myristica* in that the anthers stand terminal on the apex of the filaments in the former, while in the latter they are adnate to the filaments by their back. Since the genus *Otoba* is thus to be retained as distinct from *Myristica*, then the *Myristica Otoba* of Humboldt & Bonpland (Pl. Aequin. **2:** 78, *pl. 103.* 1809) must be given a new specific name. The combination *Otoba Otoba* proposed by Karsten (Deutsch. Fl. 578. 1882) is untenable because of being a tautonym and no other specific name appears ever to have been applied to the plant in question. The name *Otoba novogranatensis* is therefore hereby proposed for this plant. The only two known species of the genus, then, are as follows: (1) *Otoba incolor* (Warb.) Karst. (Nov. Act. Acad. Nat. Cur. **68:** 232. 1897) and (2) *Otoba novogranatensis* Moldenke (the *Myristica Otoba* of Humboldt & Bonpland).

INDEX TO AMERICAN BOTANICAL LITERATURE

1928–1932

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

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